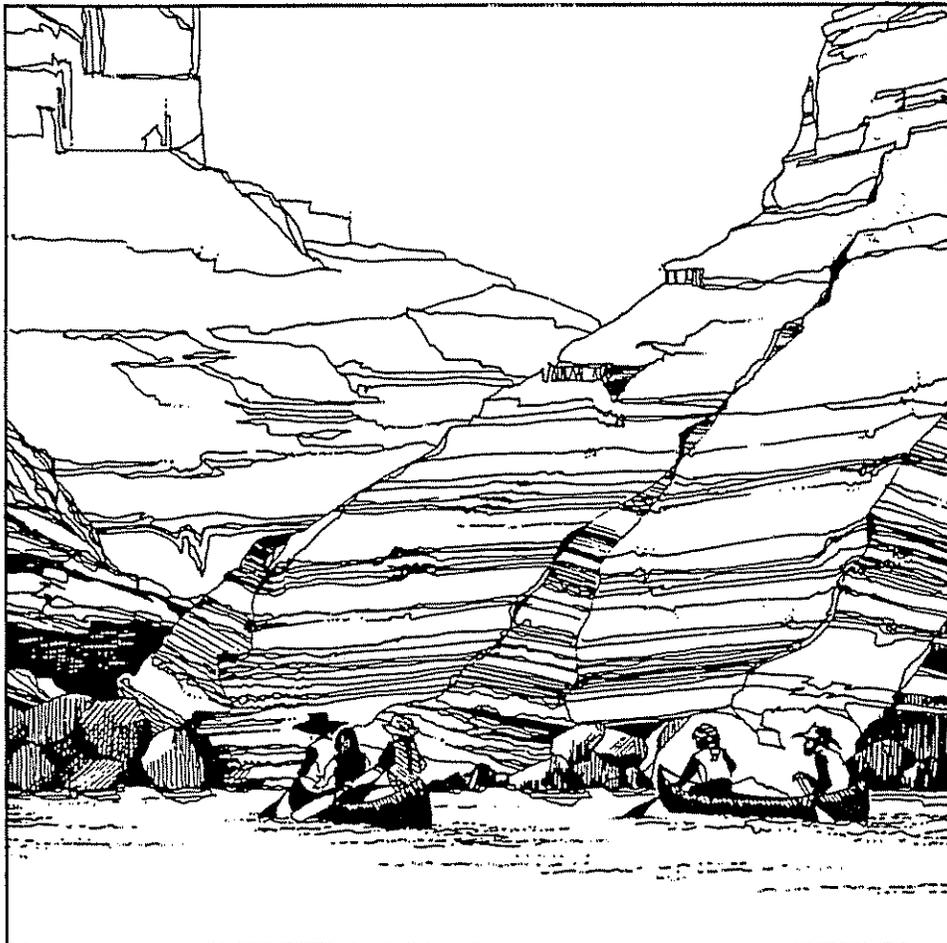


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COLORADO RIVER SYSTEM CONSUMPTIVE USES AND LOSSES REPORT 1981-1985



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**COLORADO RIVER SYSTEM
CONSUMPTIVE USES
AND
LOSSES REPORT
1981-1985**

**DRAFT
January 1991**



**United States Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Lower Colorado Region**

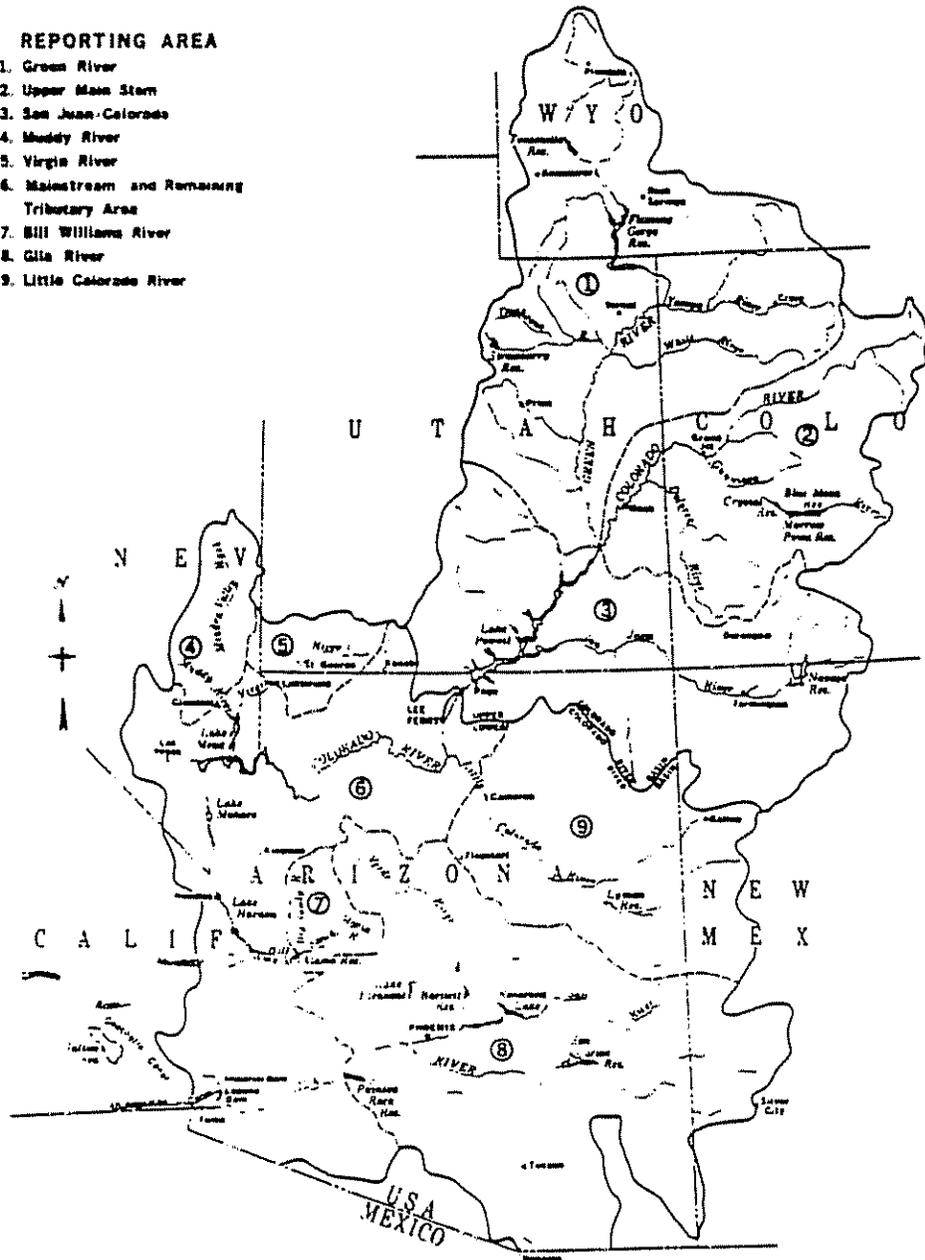
FOREWORD

This report was prepared pursuant to the Colorado River Basin Project Act of 1968, Public Law 90-537. The act directs the Secretary of the Interior to "make reports as to the annual consumptive uses and losses of water from the Colorado River System after each successive 5-year period, beginning with the 5-year period starting October 1, 1970 Such reports shall be prepared in consultation with the States of the Lower Basin individually and with the Upper Colorado River Commission and shall be transmitted to the President, the Congress, and to the Governors of each State signatory to the Colorado River Compact."

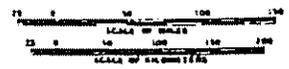
This report reflects the Department of the Interior's best estimate of actual consumptive uses and losses within the Colorado River Basin. The reliability of the estimate is affected by the availability of data and the current capabilities of data evaluation.

REPORTING AREA

1. Green River
2. Upper Main Stem
3. San Juan-Colorado
4. Muddy River
5. Virgin River
6. Mainstream and Remaining Tributary Area
7. Bill Williams River
8. Gila River
9. Little Colorado River



UNITED STATES
 DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
COLORADO RIVER SYSTEM
 CONSUMPTIVE USES & LOSSES REPORT
 PUBLIC LAW 90-537



SUMMARY

This report presents estimates of the consumptive uses and losses from the Colorado River System for each water year from 1981 through 1985. It includes a breakdown of the beneficial consumptive use by major types of use, by major tributary streams, and, where possible, by individual States.

The Colorado River rises in the Rocky Mountains of Colorado, flows southwesterly about 1,400 miles and terminates in the Gulf of California. Its drainage area of 242,000 square miles in this country represents one-fifteenth the area of the United States. Its water is used for irrigation, municipal and industrial purposes, electric power generation, mineral activities, livestock, fish and wildlife, and recreation. Large amounts are exported from the system to adjoining areas. The following table summarizes annual water use from the system by basins and States, including water use supplied by ground-water overdraft. Distribution of water use by types of use from the various reporting areas is contained within the body of the report.

Summary.-Colorado River System Uses and Losses Report, Public Law 90-537
 Water use by states, basins, and tributaries¹ (1981-1985)
 (Units: 1,000 acre-feet)

State and basin of use	Water year					Average 1981-85
	1981	1982	1983	1984	1985	
Arizona	6,187	6,143	4,237	5,041	4,838	5,085
Upper Basin	(42)	(40)	(42)	(44)	(44)	(42)
Lower Basin main stem	(1,282)	(1,127)	(910)	(989)	(1,032)	(1,070)
Lower Basin tributaries	(4,843)	(3,976)	(3,285)	(3,998)	(3,782)	(3,973)
California	4,839	4,349	3,953	4,679	4,710	4,506
Lower Basin main stem	(4,839)	(4,349)	(3,953)	(4,679)	(4,710)	(4,506)
Colorado	2,086	2,106	1,920	1,865	1,994	1,994
Upper Basin	(2,086)	(2,106)	(1,920)	(1,865)	(1,994)	(1,994)
Nevada	350	352	339	355	373	354
Lower Basin main stem	(109)	(106)	(92)	(99)	(103)	(102)
Lower Basin tributaries	(241)	(246)	(247)	(256)	(270)	(252)
New Mexico	342	425	425	417	401	402
Upper Basin	(314)	(399)	(400)	(394)	(375)	(377)
Lower Basin tributaries	(28)	(26)	(25)	(23)	(26)	(25)
Utah	782	746	718	762	879	777
Upper Basin	(668)	(633)	(596)	(638)	(755)	(657)
Lower Basin tributaries	(116)	(113)	(122)	(124)	(124)	(120)
Wyoming	341	330	346	307	336	332
Upper Basin	(341)	(330)	(346)	(307)	(336)	(332)
Other ²	1,598	1,403	1,896	1,197	1,783	1,575
Upper Basin Colorado River Storage Project reservoir evaporation	(541)	(501)	(614)	(659)	(645)	(592)
Lower Basin main stem reservoir evaporation and channel loss	(1,057)	(902)	(1,282)	(538)	(1,138)	(983)
Total--Colorado River System						
Upper Basin	3,449	3,508	3,304	3,248	3,504	3,402
Lower Basin main stem	6,230	5,582	4,955	5,777	5,845	5,878
Lower Basin tributaries	5,228	4,361	3,679	4,401	4,182	4,370
Other--Reservoir evaporation and channel loss	1,598	1,403	1,896	1,197	1,783	1,575
	16,505	14,854	13,834	14,623	15,314	15,025
Water passing to Mexico	3,997	1,817	9,782	16,992	13,396	9,197
Treaty	(1,751)	(1,495)	(1,646)	(1,694)	(1,671)	(1,652)
Minutes 218, 241, and 242	(131)	(148)	(166)	(138)	(131)	(142)
Excess release	(2,115)	(176)	(7,970)	(15,160)	(11,594)	(7,403)
Total--Colorado River System and water passing to Mexico	20,502	16,671	23,616	31,615	28,710	24,222

¹ Onsite consumptive uses and losses; includes water uses satisfied by ground-water overdraft (from tables C-2 through C-5 and LC-3).

² Represents main stem reservoir evaporation in the Upper Basin and main stem reservoir evaporation and channel loss below Lee Ferry in the Lower Basin.

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COLORADO RIVER SYSTEM
CONSUMPTIVE USES AND LOSSES REPORT

1981-1985

INTRODUCTION

The Colorado River System is composed of portions of seven States--Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. It has a drainage area of about 242,000 square miles and represents about one-fifteenth the area of the United States.

This report incorporates annual estimates of consumptive uses and losses of water from the system from 1981 through 1985. Wherever available, water use reports prepared in accordance with legal requirements concerning the operation of the Colorado River were utilized. Base data needed to estimate onsite consumptive uses were taken largely from existing reports and studies and from ongoing programs. Where current data were not available, estimated values were developed by various techniques and reasoned judgment.

In general, methodology followed the techniques normally used within the system for estimating water use.

Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994; 59 Stat. 1219), the decree entered by the Supreme Court of the United States in *Arizona vs. California, et al.* (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act, (70 Stat. 105; 43 U.S.C. 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501).

AUTHORITY

The authority for this report is contained in Public Law 90-537, the Colorado River Basin Project Act of 1968. Title VI, Section 601(b)(1) of the act reads as follows:

(b) The Secretary is directed to:

(1) Make reports as to the annual consumptive uses and losses of water from the Colorado River System after each successive 5-year period, beginning with the 5-year period starting October 1, 1970. Such reports shall include a detailed break down of the beneficial consumptive use of water on a State-by-State basis. Specific figures on quantities consumptively used from the major tributary streams flowing into the Colorado River shall also be included on a State-by-State basis. Such reports shall be prepared in consultation with the States of the Lower Basin individually and with the Upper Colorado River Commission, and shall be transmitted to the President, the Congress, and to the Governors of each State signatory to the Colorado River Compact.

PLAN OF STUDY

No plan of study was submitted for this report. The same procedures as were outlined in the previous 5-year plan of study were used in preparing this report.

STUDY REPORTING AREAS

The estimated drainage area of the Colorado River System in the United States is about 242,000 square miles.

The river originates in the Rocky Mountains of Colorado and Wyoming, flows southwest about 1,400 miles, and terminates in the Gulf of California. The system consists of portions of seven States: Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming. The drainage area was divided into nine subbasins for the purpose of this report.

The Colorado River Compact, signed November 24, 1922, was established because the Upper Basin States were concerned that any storage on the river would be put to use more rapidly by the Lower Basin States, thus allowing them to claim appropriative rights. The Upper Basin States wanted provisions for their future development.

The term "Upper Basin States" refers to the States of Colorado, New Mexico, Utah, and Wyoming. "Lower Basin States" refers to the States of Arizona, California, and Nevada. However, the Upper Colorado River Basin refers to the hydrologic boundaries. Lee Ferry is the division point between the Upper Colorado River Basin and the Lower Colorado River Basin. Therefore, the hydrologic boundaries include portions of Arizona in the Upper Colorado River Basins and portions of Utah and New Mexico in the Lower Colorado River Basin. Hydrologic boundaries are shown on the map on page ii.

The major tributary streams selected as reporting areas in the Upper Colorado River Basin are: Green River (Wyoming, Colorado, Utah); Upper Main Stem (Colorado, Utah); and San Juan-Colorado (Colorado, New Mexico, Utah, Arizona).

Five tributary areas in addition to the main stem were selected in the Lower Colorado River Basin: Little Colorado River (Arizona, New Mexico); Virgin River (Utah, Arizona); Muddy River (Nevada); Bill Williams River (Arizona); Gila River (Arizona, New Mexico); and remaining areas in Arizona, Nevada, and Utah. The outflow point and drainage area for each is shown in table C-1. The boundaries of the reporting areas are shown on the map on page iv. A brief description of each reporting area follows.

Upper Colorado River Basin

Green River, Wyoming-Colorado-Utah

The Green River reporting area comprises about 44,800 square miles in southwestern Wyoming, northwestern Colorado, and northeastern and east-central Utah.

Principal tributaries of the Green River are Blacks Fork, New Fork, and Big Sandy Creek in southwestern Wyoming; Yampa and White Rivers on the western slope of the Continental Divide in northwestern Colorado; and the Price, Duchesne, and San Rafael Rivers in eastern Utah. These streams are fed by numerous headwater lakes.

The largest towns in the reporting area are Rock Springs and Green River in Wyoming; Vernal and Price in Utah; and Craig, Steamboat Springs, and Meeker in Colorado.

Mineral production is the major industry. Oil and natural gas are of primary importance, as are coal,

gilsonite, asphalt, and trona (soda ash). Thermal electric power production is becoming an increasingly important industry.

Agriculture ranks near mineral production in importance to the local economy. Agricultural development is centered around livestock production, primarily beef cattle and sheep. Because of a short growing season, crop production is limited largely to small grain, hay, and pasture. These crops are used as winter livestock feed and complement the vast areas of public grazing lands.

Irrigation consumptive use accounts for about 75 percent of the total water use in the Green River reporting area exclusive of any share of main stem evaporation. Nearly 580,000 acres of land are irrigated in an average year. Large exports of water are made to the Great Basin in Utah.

Upper Main Stem, Colorado-Utah

The Upper Main Stem reporting area is drained by the Colorado River and its tributaries above the mouth of the Green River. Principal tributaries are the Roaring Fork, Gunnison, and the Dolores Rivers. The Upper Main Stem reporting area consists of 26,200 square miles, with about 85 percent of the area in Colorado and the remainder in Utah.

Grand Junction, Montrose, and Glenwood Springs are the principal towns in the Colorado portion of the upper main stem of the Colorado River. Moab is the only major community in the Utah portion of the upper main stem of the Colorado River.

Mineral production is the predominant industry. This area is the Nation's chief source of molybdenum and is a major source of vanadium, uranium, lead, zinc, coal, and gilsonite. On the Upper Main Stem reporting area, as in that of the Green River, agriculture centers around production of livestock which feeds on irrigated lands to complement the large areas of rangeland. Somewhat more diversification of crops occur in the Upper Main Stem, however, with some major land areas devoted to corn, beans, potatoes, table vegetables, and fruit. This diversification is made possible by climatic and topographic conditions that create favorable air drainage and minimize frost damage.

Irrigation consumptive use accounts for about 58 percent of the water use in the Upper Main Stem reporting area exclusive of any share of main stem evaporation. In an average year about 555,000 acres of land are irrigated.

A considerable amount (29 percent) of water is exported to serve agricultural and municipal needs on the eastern slope of the Continental Divide in Colorado.

San Juan-Colorado, Colorado-New Mexico-Utah- Arizona

The San Juan reporting area is drained by the Colorado River and its tributaries below the mouth of the Green River and above Lee Ferry, Arizona. The largest of the tributary stream is the San Juan River which heads on the western slope of the Continental Divide in southwestern Colorado. Principal tributaries of the San Juan River are the Navajo,

Piedra, Los Pinos, Animas, and La Plata Rivers. The other main tributaries in the basin are the Dirty Devil, Escalante, and Paria Rivers, which drain a portion of the eastern slope of the Wasatch Plateau in Utah. The reporting area includes about 38,600 square miles in portions of Utah, New Mexico, Arizona, and Colorado.

The largest towns are Durango and Cortez in Colorado; Monticello and Blanding in Utah; Farmington in New Mexico; and Page in Arizona.

Mining and agriculture form the economic base for the San Juan-Colorado reporting area. The agricultural development is similar to that of the Upper Main Stem with most of the cropland devoted to livestock feeds but with production of diversified market crops on lands with favorable air drainage. The main market crops are fruit, vegetables, and dry beans. Oil, natural gas, and coal are the most important minerals produced. Thermal electric power production is increasingly important to the economy of the area.

Irrigation accounts for the largest use of water, about 78 percent of the San Juan reporting area use exclusive of any share of main stem evaporation. About 275,000 acres of land are irrigated in an average year.

Lower Colorado River Basin

Main Stem Below Lee Ferry, Arizona-California-Nevada

The Colorado River has a length of over 700 miles and a drainage area of

132,300 square miles within the Lower Colorado River System in the United States. The dividing point between the Upper and Lower Basin is Lee Ferry. Diversions are made at Lake Mead to the rapidly expanding North Las Vegas-Las Vegas-Henderson-Boulder City area for municipal and industrial purposes. The river below Lake Mead courses through canyons and broad alluvial valleys interspersed with bordering groups of mountains. Lakes Mohave and Havasu provide flood control and regulatory storage below Lake Mead. Lake Havasu also provides a forebay for pumped diversion to the Central Arizona Project (CAP) in Arizona and export to the Metropolitan Water District of Southern California. Lake Mohave reregulates Hoover Dam releases for power production and for deliveries to Mexico. Lesser structures downstream include Senator Wash, Laguna, Headgate Rock, Palo Verde, Imperial, and Morelos Dams. Senator Wash and Laguna Dams provide very limited amounts of reregulation capacity while the others are used principally for diversion.

Diversions below Lake Mead for agriculture, municipal and industrial, power, export, and other purposes are of the magnitude of 6 million acre-feet annually. A portion of these diversion is satisfied from upstream return flow. Yuma and Lake Havasu City in Arizona and Needles and Blythe in California are the major cities along the main stem below Lake Mead. Current irrigated lands adjacent to the main stem are estimated to cover approximately 275,000 acres

Remaining Areas in Arizona-Nevada-Utah

Development away from the Colorado River main stem is limited by the availability of water and the rugged terrain.

Most of the irrigated lands in this area are located in the lower reach of the Virgin River and Las Vegas Valley in Nevada, on Kanab Creek in Arizona and Utah, and the lower portions of the Gila and Bill Williams Rivers in Arizona. Reporting period irrigated land averaged approximately 160,000 acres.

North Las Vegas, Las Vegas, Henderson, and Boulder City in Nevada, and Kingman and Williams in Arizona, are the leading cities.

Both the remaining areas in Arizona-Nevada-Utah and the main stem below Lee Ferry, Arizona-California-Nevada are combined into one subbasin, subbasin 6 on the frontispiece map, but reported separately.

Little Colorado River, Arizona-New Mexico

The Little Colorado River drainage area occupies a large part of northern Arizona and a portion of west-central New Mexico. It originates on the north slopes of the White Mountains about 20 miles above Springerville, Arizona. The river has a main stem length of about 356 miles and joins the Colorado River on the east boundary of Grand Canyon National Park about 78 miles downstream from Glen Canyon Dam.

A series of saline springs near the mouth of the Little Colorado River produces an estimated 160,000 acre-feet of water annually. The U.S. Geological Survey (USGS) gauging station near Cameron, Arizona, is located on the Navajo Indian Reservation about 45 miles upstream from the mouth. Streamflow is undependable and erratic and is subject to flash floods of considerable magnitude. Flow at the gauging station during the 1981-85 period varied from 41,150 acre-feet in 1981 to 323,300 acre-feet in 1983. Only minor development of the ground water has occurred because of low yields and poor quality. Excessive erosion and sediment deposition plague the area.

Agriculture is concentrated along the main stem of the Little Colorado River in the upper reaches of the river, on Silver Creek, a southern tributary, and on the Zuni River in New Mexico. Current irrigated lands in the basin are estimated to average approximately 32,500 acres. Irrigated acreage in the basin is subject to variation because of frequent water shortages and inadequate storage facilities. Population is predominately rural with a relatively large Indian segment. Principal cities include Flagstaff, Winslow, and Holbrook in Arizona, and Gallup, Zuni, and Pueblo in New Mexico. Leading industries include tourism, recreation, manufacturing, mining, and forest management.

Virgin River, Arizona-Utah

The Virgin River originates in western Kane County, Utah. It flows south-westerly through the southwest corner

of Utah and the northwestern corner of Arizona and empties into the northern extremity of the Overton Arm of Lake Mead in Nevada. The selected outflow point is the long-term USGS gauging station at Littlefield, Arizona, which is about 36 miles upstream from Lake Mead and about 10 miles above the Arizona-Nevada State line. The river is fed chiefly from tributaries heading in the southern high plateaus and mountains in Utah. Several springs contribute water to the river at a relatively uniform rate. The two most significant of these springs are located near LaVerkin, Utah, and Littlefield, Arizona, and both are highly saline. Agricultural and municipal developments in Nevada below the selected outflow point are included in "remaining areas," as shown on the frontispiece map.

The major irrigated areas are located in the LaVerkin-Hurricane-St. George-Santa Clara areas of Washington County, Utah, and in the Littlefield area of Mohave County, Arizona. Small irrigated areas are scattered throughout. Irrigated lands were estimated to average approximately 25,000 acres. Ground water has been developed to a limited degree. Population is predominately rural with St. George, Utah, being the principal city in the basin.

Muddy River, Nevada

The Muddy River, a tributary of the Virgin River prior to the existence of Lake Mead, originates from warm springs in northern Clark County, Nevada, about 10 miles northwest of Glendale. The river flows southeasterly

for about 30 miles and terminates at the northwestern extremity of the Overton Arm of Lake Mead near Overton, Nevada. Meadow Valley Wash, the major tributary of Muddy River, originates in northeastern Lincoln County and flows south to join the parent stream at Glendale. The USGS gauging station near Glendale is about 2.4 miles downstream from Meadow Valley Wash. Outflow varies little from year to year. Meadow Valley Wash, although perennial in the vicinity of Caliente, is normally dry in the last 50-mile reach above Glendale. Irrigated lands averaged approximately 10,800 acres. The entire basin is sparsely populated.

Bill Williams River, Arizona

The Bill Williams River is formed by the convergence of the Big Sandy and Santa Maria Rivers about 7.5 miles above Alamo Dam. The river above Alamo Dam drains an area of about 4,700 square miles from small, rough mountain ranges and intervening valleys in parts of Mohave, La Paz, and Yavapai Counties. Alamo Dam and Reservoir, primarily a flood control structure completed in 1968, was built to protect downstream development along the Colorado River. A minimum pool is maintained for recreation and game management purposes. Releases up to a maximum of 2,000 ft³/s from the allocated conservation pool above the minimum pool are coordinated with releases from main stem reservoirs. Releases from Alamo Dam and runoff from the intervening area flow westerly and enter at the lower end of Lake Havasu just above Parker Dam.

Irrigated lands are estimated to average approximately 10,000 acres. The limited development in the basin is dominated by copper mining at the unincorporated town of Bagdad. A large portion of the water supply in the basin is obtained from ground-water pumpage. Releases from Alamo Dam and Reservoir during the 1981-85 period varied from 17,350 acre-feet in 1982 to 644,500 acre-feet in 1985.

Gila River, Arizona-New Mexico

The Gila River is the largest tributary to the Colorado River in the Lower Colorado River System. The drainage area extends from the Continental Divide in New Mexico to the river's mouth near Yuma, Arizona. Elevations in the basin range from nearly 12,000 feet in the eastern mountains to about 150 feet at the mouth. The selected outflow point for the basin is at Painted Rock Dam, a flood control structure located about 20 miles west of Gila Bend, Arizona. The drainage area above Painted Rock Dam is about 50,900 square miles, of which 5,600 square miles are in New Mexico, 44,200 square miles are in Arizona, and 1,100 square miles in Mexico. The dam was constructed to protect agricultural and urban developments downstream.

Nearly three-fourths of the population of the Lower Colorado River System reside in the Gila River Basin in the metropolitan Phoenix and Tucson areas. Industry and recreation play a large part in the economy. About two-thirds of the agricultural development in the Lower Colorado River System is located in the Gila River Basin. This

development is concentrated in the central area of Maricopa, Pinal, and Pima Counties and is supported to a large degree by a long-term overdraft of the ground-water resources. Estimated irrigated lands ranged between 755,000 and 1,228,000 acres for the reporting period and averaged 965,000 acres. Nearly all of the surface water resources in the basin have been developed for decades.

TERMINOLOGY

The Colorado River is not only one of the most highly controlled rivers in the world, but is also one of the most institutionally encompassed. A multitude of legal documents, known collectively as the "Law of the River," affect and dictate its management and operation. Major documents include:

Colorado River Compact--1922
Boulder Canyon Project Act--1928
California Limitation Act--1929
California Seven Party Agreement--1931

Mexican Water Treaty--1944
Upper Colorado River Basin
Compact--1948 Colorado River Storage
Project Act--1956
United States Supreme Court Decree in
Arizona vs. California--1964
Colorado River Basin Project Act--1968
Minute 242 of the International
Boundary and Water Commission,
United States and Mexico--1973
Colorado River Basin Salinity Control
Act--1974, amended 1984

The Colorado River System is defined in the Colorado River Compact of 1922 as "...that portion of the Colorado River and its tributaries within the United States,"

whereas the Colorado River Basin is defined as "...all of the drainage area of the Colorado River System and all other territory within the United States of America to which waters of the Colorado River System shall be beneficially applied." The compact divided the Colorado River Basin into two subbasins--the "Upper Basin" and the "Lower Basin," with Lee Ferry as the division point on the river. Lee Ferry, located in Arizona, is a point in the main stem 1 mile below the mouth of the Paria River. For the purpose of this report, the Great Divide Basin, a closed basin in Wyoming, and the White River, also a closed basin, in Nevada have not been considered as part of the Colorado River System since flows from these basins never reach the Colorado River. Diversions from the system to areas outside its drainage area are considered herein as exports and have not been classified by types of use.

Beneficial consumptive use is normally construed to mean the consumption of water brought about by human endeavors and in this report includes use of water for municipal, industrial, agricultural, power generation, export, recreation, fish and wildlife, and other purposes, along with the associated losses incidental to these uses.

The storage of water and water in transit may also act as losses on the system although normally such water is recoverable in time. Qualitatively, what constitutes beneficial consumptive use is fairly well understood; however, an inability to exactly quantify these uses has led to various differences of opinion. The practical necessity of administering the various water rights, apportionments, etc., of the Colorado River has

led to definitions of consumptive use or depletions generally in terms of "how it shall be measured." The Upper Colorado River Basin Compact provides that the Upper Colorado River Commission is to determine the apportionment made to each State by "...the inflow-outflow method in terms of manmade depletions of the virgin flow at Lee Ferry...." There is further provision that the measurement method can be changed by unanimous action of the Commission. In contrast, article 1(A) of the decree of the Supreme Court of the United States in *Arizona vs. California* defines, for the purpose of the decree, "Consumptive use means diversions from the stream less such return flows thereto as are available for consumptive use in the United States or in satisfaction of the Mexican Treaty obligation." Nearly all the water exported from the Upper Colorado River System is measured; however, the remaining beneficial consumptive use, for the most part, must be estimated using theoretical methods and techniques. In the Lower Colorado River System tributaries to the main stem, similar methods must be employed to determine the amount of water consumptively used.

Reservoir evaporation loss is a consumptive use associated with the beneficial use of water for other purposes. For the purpose of this report, main stem reservoir evaporation is carried as a separate item for the Upper and Lower Basins.

Channel losses within the system are normally construed to be the consumptive use by riparian vegetation along the stream channel (or conveyance route) and the evaporation from the stream's

water surface and wetted materials. Seepage from the stream normally appears again downstream or reaches a ground-water aquifer where it may be usable again. A decided lack of data and acceptable methodology along with the intermittent flow characteristics of many Southwest streams combine to make a reasonable determination of channel loss difficult. Channel losses have not been estimated for this report within the Upper Basin nor on the tributaries of the Lower Colorado River main stem. Channel losses on the main stem below Lee Ferry and below Hoover Dam were estimated.

METHODOLOGY AND DATA ADEQUACY

This report is based almost entirely on data obtained from ongoing programs and current reports. Quantitative measurements of water use were used wherever available, but the majority of the basin water use was theoretically calculated. The following sections describe these calculations for both the Lower Colorado River Main Stem and the Upper and Lower Colorado River Basin tributaries.

Colorado River Basin Tributaries

In the tributary areas of the basin, records of diversions and return flows are not complete enough to allow direct calculation of consumptive water use. Theoretical and indirect methods of estimating consumptive use must then be relied upon. In the New Mexico portion of the Gila River Basin, the

annual consumptive use of water is reported by the New Mexico Interstate Stream Commission, pursuant to article VII of the March 9, 1964, decree of the United States Supreme Court in *Arizona vs. California*, et al.

Agriculture

The percentages of irrigation consumptive use range between 64 and 69 percent for the Upper Basin tributaries and between 73 and 81 percent for the Lower Basin tributaries. Both percent ranges exclude main stem evaporation. The annual irrigated acreage of most crops grown within each reporting area was estimated from information published in the yearly *State Agriculture Statistics*. Irrigated pasture and some minor crops not reported by the State statistics were estimated from information in the 1978 and 1983 *National Census of Agriculture* with supporting information from the comprehensive framework study and various other local reports. The total irrigated acreage values for the Upper and Lower Basins are shown in tables UC-7 and LC-9, respectively.

Since most of these data were presented on a county basis, it was necessary to separate them into smaller reporting areas for computational purposes. This was accomplished using land inventory maps and relationships developed for the comprehensive framework study.

These subbasins generally follow tributary stream basin and State boundaries. A representative climatic station was selected for each subbasin. Using historical records of temperature,

precipitation, and frost dates, a consumptive use rate was computed for each major crop in each of the reporting years. For the purpose of this report, the consumptive use rates were computed using the modified Blaney-Criddle evapotranspiration formula in the version described in the Soil Conservation Service Technical Release No. 21, "Irrigation Water Requirements," revised September 1970. Irrigation consumptive rates were determined by subtracting the effective precipitation from the consumptive use rates. Effective precipitation for the Upper Basin was computed using the Soil Conservation Service method. This method is referenced in "SCS Technical Release No. 21." (It should be noted that this method estimates less effective precipitation than the Reclamation method. Previous reports used the Reclamation method of computing effective precipitation.) The values of irrigation consumptive use rates were applied to the estimates of irrigated acreage to yield the final values of irrigation consumptive use.

An exception to this procedure occurred in the Lower Basin in the "low desert" regions of Arizona and Nevada where the Blaney-Criddle formula was used to estimate the crop consumptive use. This departure was based on the research results of Leonard Erie, et al. Seasonal crop consumptive use factors ("K") for the lower elevation desert areas were selected from Conservation Research Report Number 29, "Consumptive Use of Water by Major Crops in the Southwestern United States," issued May 1982 by the United States Department of Agriculture. Effective precipitation was derived from criteria

developed for the area by Wayne Criddle, former Utah State Engineer.

These theoretical consumptive use calculations were based on the assumption of full water supply during the crop growing season. However, it is estimated that in an average year, about 37 percent of the irrigated lands in the Upper Basin receive less than a full supply of water, either due to lack of distribution facilities or junior water rights. The degree to which these lands suffer shortages varies widely from year to year, depending in large part on the magnitude of runoff. For this study, an estimate of the short supply service lands was made for each subbasin, primarily on the basis of reports and investigations collected for the comprehensive framework study. A streamflow gauging station was selected within each subbasin and the magnitude of the recessional portion of the annual hydrograph was used as an index to select the date at which consumptive use calculations should be terminated for the short supply lands.

Comprehensive framework studies of the incidental consumptive use of water associated with irrigation indicated that this use varied between 5 and 29 percent of the irrigation consumptive use, depending upon the location of the study area within the Colorado Basin. These percentages were used in the Upper Basin and an average value of 15 percent was used in the Lower Basin to adjust the calculated consumptive use.

The agricultural data is generally adequate for use in this report. With the exception of Utah, each state prepared annual county irrigated

acreage estimates of the harvested crops during the reporting period. These statistics are assumed to be reliable. The irrigated pasture values were based largely on the 1978 and 1983 National Census of Agriculture since the State statistics do not include pastureland. Because of the length of time between reporting dates, this item needs to be considerably strengthened. In this regard, Wyoming and New Mexico have initiated aerial photographic mapping of their State's irrigated acreage to verify the annual statistical sampling. Other areas of agricultural data collection that need to be updated and verified are (1) the consumptive water use of lands that receive less than a full seasonal supply of irrigation water and the areal extent of these lands, and (2) the amount of incidental seepage and phreatophytic losses associated with irrigation.

Reservoir Evaporation

A comprehensive listing was developed of all reservoirs in the Colorado River Basin which included the latitude, elevation, and surface area at total capacity for each reservoir.

Monthly content records were obtained for those reservoirs for which records are available. The average annual water-surface area was determined for each year of the reporting period. For those reservoirs lacking records, a "fullness factor" was estimated on the basis of reservoir use and historical hydrologic conditions. These "fullness factors" were then used to obtain estimates of average annual water-surface area for the unreported reservoirs. For the majority of the

basin, historical evaporation rates were used to determine reservoir evaporation.

In the Upper Basin, a multiple regression equation relating gross annual evaporation to elevation and latitude was developed. Adjustments to computed evaporation were made based on climatic subareas. In the Lower Basin, evaporation values were calculated for each climatic subarea. An account was taken of precipitation and runoff salvage to determine net evaporation rates. The net evaporation rates were applied to the estimates of average annual water-surface area to yield the values of annual reservoir evaporation.

An exception to this procedure was the determination of evaporation from what are called the main stem reservoirs shown in table UC-1. Predetermined average evaporation rates were applied to historical surface areas to yield values of evaporation on a monthly basis.

Ground Water *new*

Currently, all ground-water pumpage is counted as consumptive use charged against the Colorado River Basin. Obviously, this is not necessarily true. Depending on the location and depth of the well and what types of soils are present in the area, it is possible that little or none of the water pumped would have contributed to the Colorado River System for hundreds or even thousands of years. It has recently been proposed that an interagency study team be put together consisting of personnel from various State Engineers Offices, Bureau

of Reclamation, and any other pertinent agencies. This study team would establish guidelines for computing what amounts of ground water pumped should be charged against the Colorado River Basin. These guidelines will need to be established on an area by area basis rather than one set percentage for the entire basin. Results of this study will be incorporated in future Consumptive Uses and Losses Reports. However, until these guidelines are established, the Consumptive Uses and Losses Reports will continue to report all ground-water pumpage as depletion from the system.

Currently, the Arizona portion of the Upper Basin is the only part of the basin that reports ground-water pumpage as consumptive use. Although significant ground-water usage occurs in Arizona, Nevada, and New Mexico, for purposes of this report ground-water overdraft has not been taken into account in the computation of tributary consumptive use. It should be noted that present ground-water overdraft in Arizona has been estimated to be approximately 2.2 million acre-feet per year.

Stockpond Evaporation and Livestock

Stockpond surface areas were estimated from the May 1975 Soil Conservation Service (SCS) publication, "Livestock Water Use." The subbasin stockpond areas were subdivided by State and basin using the livestock population distribution. The same procedure used to calculate the unmeasured reservoir evaporation was used to estimate the stockpond evaporation.

Livestock population data were taken from annual State Agriculture Statistics and the 1978 and 1983 Census of Agriculture. Livestock population data included cattle, sheep, horses, and hogs. Consumption rates for the various livestock were derived from various reports, including the SCS publication, "Livestock Water Use," May 1975.

Stockpond and livestock data are adequate to prepare an estimate of this use. Considering the small amount of water use, any refining effort would be best spent on the irrigation or evaporation categories.

Mineral Resources

Arizona leads the nation in the production of copper and the net water use for its production represents about 90 percent of the total water use for mineral resources in the Lower Basin. The Upper Basin uses water in the production of numerous minerals in addition to energy-related materials such as oil and natural gas.

Estimates of the water consumptively used were based largely on phone surveys conducted by the U.S. Geologic Survey in 1985, that quantified water use in the basin. Intermediate years were interpolated between 1980 and 1985. In some cases where, for privacy reasons, companies were unwilling to supply information, information was obtained from the U.S. Bureau of Mine

Thermal Electric Power

The net use of water for the production of thermal electric energy from the

tributaries of the Colorado River Basin was estimated from records obtained from the various power companies in the Basin. These records were complete and were judged to be accurate.

Municipal and Industrial

The basis for estimating municipal and industrial uses was the urban and rural population within the reporting areas. Preparation of annual population estimates was guided by the 1970 and 1980 censuses, various State and county statistical reviews, and reports that included population estimates for local areas. The yearly population estimates for the Upper and Lower Basins are shown in tables UC-8 and LC-10, respectively. Water withdrawal rates for urban and rural uses in the various reporting areas were derived from available studies in the metropolitan areas, State Water Plan reports, and Bureau of Reclamation technical guidelines. These withdrawals were then converted to depletions using average basin consumptive use factors.

The population of the Colorado River System, estimated at nearly 4.5 million in 1985, has increased at an annual rate slightly in excess of 3 percent during this reporting period. A large portion of the population resides within Maricopa and Pima Counties, Arizona, and in Clark County, Nevada. Sixty percent of the Upper Basin and about 20 percent of the Lower Basin population were classified as rural with a significantly smaller per capita use of water. Both the urban and rural areas have the mutual problem of providing an adequate current and future water supply for a growing population in a

water-short area. As a result of almost continuous studies concerning these problems, adequate production and effluent records are usually available to adequately assess water use.

Transbasin Diversions *Exports*

Nearly all the transbasin diversions both out of and into the Colorado River System were measured and reported by the Geological Survey, or local water commissioners and users. The remainder were estimated on the basis of past records and capacity of facilities. Due to the high degree of measurement, this area of basin consumptive use is considered to be quite accurately determined.

Lower Colorado River Main Stem

The annual consumptive use of water from the Colorado River main stem by the States and exports from the system were taken from the Bureau annual report entitled "Compilation of Records in Accordance with Article V of the Decree of the United States in Arizona vs. California." The estimated Colorado River component of the combined surface and subsurface return flows accruing to Las Vegas Wash and discharging into Lake Mead, as taken from the report, is credited to Nevada's municipal and industrial water uses. Unmeasured subsurface return flows were estimated below Hoover Dam, based partially on preliminary information supplied by the Task Force on Ground-Water Return Flows. All unmeasured subsurface return flows

were credited to the irrigation water use taken from the Article V report, and were divided between California and Arizona based on their respective irrigation diversions.

Gross evaporation from Lake Mead is estimated by the USGS and published in its annual Water Resources Data reports. Net evaporation for Lake Mead is estimated by subtracting precipitation at nearby Boulder City, Nevada, from the gross evaporation. Net evaporation from Lakes Mohave and Havasu and Senator Wash Reservoir was derived incorporating Lake Mead gross evaporation and local precipitation records and operating data.

Annual channel losses were estimated as the inflow or outflow necessary to balance a simplified water budget for the Lee Ferry to Hoover Dam and Hoover Dam to International Boundary reaches. Channel losses include evaporation, seepage, phreatophyte consumptive use, and bank storage.

The accuracy of flow measurements of the Colorado River mainstream for use in determining the channel losses values in table LC-1 is in question. The gauge error of an "excellent" USGS flow gauge is 5 percent. Actual flow at Lee Ferry, Hoover Dam, or to Mexico may therefore vary by 90,000 acre-feet for the low flow entering Mexico in 1982 to over 1.1 million acre-feet for 1984 flow below Hoover. Such inaccuracies, though a very small percent of total flow, will have dramatic effects on apparent channel loss computations, as reflected by channel gains.

The annual land use, water supply, and water use information being gathered

for the operation, maintenance, and administration of the Colorado River main stem below Lee Ferry is believed to be generally adequate in quantity, quality, and extent. These data are under constant review and are being continually upgraded. Studies and programs are in progress to remedy a lack of data on return flows from main stem diversions.

BENEFICIAL CONSUMPTIVE USES AND LOSSES

A summary table of the Colorado River System total annual water uses, 1981 through 1985, by states and water flowing to Mexico is shown on page iv. Tables C-2 through C-6 show on a year basis the same information broken down by State, basin, and type of use. Water use within the selected reporting areas is discussed below.

Upper Colorado River Tributaries

Summaries of estimated annual consumptive uses and losses in the Upper Colorado River Basin for each of the reporting years, broken down by State, reporting area, and type of use are shown in tables UC-2 through UC-

Estimated main stem reservoir evaporation is shown in table UC-1. Technically, these are not all main stem reservoirs but are reservoirs that participate in the Colorado River Storage Project (CRSP). The Basin Commission designates which reservoirs in the CR have evaporation losses charged to the State and which have losses charged to

the basin as a whole. Reservoirs listed in table UC-1 are those to be charged to the basin as a whole. These reservoir evaporation losses amount to about 15 percent of all Upper Basin losses.

Upper Basin consumptive use varied between 3.9 million to 4.2 million and averaged 4.0 million acre-feet per year for the reporting period, 1981 through 1985. Agricultural uses accounted for about 57 percent of the total Upper Basin consumptive uses and losses. Irrigated acreages fluctuated very little during this period, ranging between 1.37 million acres to 1.45 million acres, and averaged 1.41 million acres per year. Variation in consumptive use during the reporting period was largely due to year-to-year changes in climatic conditions.

Transbasin exports, the second largest Upper Basin use, on the average accounted for 17 percent of basin use, showed year by year variation during the reporting period ranging from a high of 820,000 acre-feet in 1982 to a low of 577,000 acre-feet in 1983. Exports were reduced during 1983 and 1984 due to record amounts of winter precipitation in the Rocky Mountain region, which produced abundant water supplies on the Front Range of Colorado, and in the Great Basin of Utah.

Water uses for thermal electric power generation remained fairly constant, averaging about 120,000 acre-feet per year, which represents about 3 percent of consumptive use in the Upper Basin. Increases noted in past reports were primarily due to new powerplants coming on line, whereas there have been no new power projects constructed during this reporting period.

Lower Colorado River Main Stem

Table LC-1 shows main stem reservoir evaporation and apparent channel losses, and table LC-3 shows water uses along the lower Colorado River main stem and flood plain including water passing to Mexico. Water passing to Mexico is made up of deliveries in satisfaction of the Treaty, deliveries made pursuant to Minute No. 242, Gila River flood releases, regulatory waste and anticipatory flood control releases from the main stem. The latter three are combined as excess releases in table LC-3 and for this reporting period totaled slightly more than 37 million acre-feet. The previous 5-year reporting period had identified excess releases to Mexico totaling about 5.4 million acre-feet, with nearly 80 percent of this total occurring in 1980 and corresponding to completion of initial filling of the Upper Basin's Lake Powell.

Annual average main stem reservoir evaporation consumed approximately 1.0 million acre-feet.

Transbasin diversions continued to be the single highest consumer. For the current reporting period, as for the preceding reporting period, transbasin diversions continued to account for approximately 72 percent of the Lower Colorado River main stem depletions.

Lower Colorado River Tributaries

Tables LC-4 through LC-8 show annual water uses within states by tributary and type of use. Lower Basin consumptive use was estimated to be about 5.2 million acre-feet in 1981,

3.7 million acre-feet in 1983, and 4.2 million acre-feet in 1985. The average for 1981-85 was about 4.4 million acre-feet.

Significant ground-water usage occurs in Arizona, Nevada, and New Mexico. For the purpose of this report, ground-water overdraft has not been taken into account in the computation of tributary consumptive use. Also, tributary channel loss and salvage were not evaluated. However, it should be noted that present ground-water overdraft in Arizona has been estimated to be approximately 2.2 million acre-feet per year.

Consumptive use for the irrigation of crops represents between 73 and 81 percent of the total water use in the Lower Colorado tributary areas. Estimated annual consumptive use for the Lower Basin during the 5-year period average about 3.2 acre-feet per acre, varying from approximately 1.1 acre-feet per acre in parts of New Mexico to over 5 acre-feet in the western portion of the basin. Estimated crop

consumptive use varied considerably from year to year on the basis of climatic conditions, and acreage fluctuations, from a high of 4.3 million acre-feet in 1981 to a low of 2.7 million acre-feet in 1983. Irrigated lands amounted to about 1.47 million acres in 1981 but had decreased to about 980,000 acres in 1983. The decrease in irrigated acreage occurred primarily in the Gila River tributary, according to State agriculture statistics.

The consumptive use of water for municipal and industrial purposes is estimated to have increased by about 44 percent for 1985 when compared with the ending year of the previous reporting period. Nearly 60 percent of the increase occurred in 1981.

Water supply conditions were characterized by near normal runoff in 1981, exceptionally poor runoff in 1982, and extremely large runoff in 1983, 1984, and 1985. In addition, the runoff in 1985 produced an outflow below Painted Rock Dam of 2,385,000 acre-feet.

**Table C-1.—Drainage area of the Colorado River System,
Area within each State and Mexico by major tributary streams**

Units = 1,000 square miles

Major tributary streams and their selected outflow points	Wyoming	Colorado	Utah	New Mexico	Arizona	Nevada	California	Total	Mexico
Green River at Colorado River confluence, Utah	17.1	10.6	17.1	-	-	-	-	44.8	-
Upper Main Stem at Green River confluence, Utah	-	22.2	4.0	-	-	-	-	26.2	-
San Juan-Colorado at Lee Ferry, Arizona	-	5.8	16.2	9.7	6.9	-	-	38.6	-
Little Colorado River near Cameron, Arizona	-	-	-	5.3	21.2	-	-	26.5	-
Virgin River at Littlefield, Arizona	-	-	3.0	-	1.9	0.2	-	5.1	-
Muddy River near Glendale, Nevada	-	-	-	-	-	6.8	-	6.8	-
Bill Williams River below Alamo Dam, Arizona	-	-	-	-	4.7	-	-	4.7	-
Gila River below Painted Rock Dam, Arizona	-	-	-	5.6	44.2	-	-	49.8	(1.1)
Main stem and remaining areas in Lower Basin	-	-	0.6	-	28.3	6.9	3.6	39.4	(0.1)
Colorado River System at Southerly International Boundary	17.1	38.6	40.9	20.6	107.2	13.9	3.6	241.9	(1.2)
Colorado River System above Lee Ferry	17.1	38.6	37.3	9.7	6.9	-	-	109.6	-
Colorado River System below Lee Ferry	-	-	3.6	10.9	100.3	13.9	3.6	132.3	(1.2)

Table C-2.--Summary of estimated water use by States and types of use
1981

State	Estimated beneficial consumptive uses and losses ¹								Total
	Reservoir evaporation	Irrigated agriculture ²	Municipal and industrial ³	Fish and wildlife recreation	Export outside system	Export within system	Unmeasured return	flow	
Arizona	279.7	5,452.6	513.2	53.9	0.0	3.0	-135	6,167.4	
California	0.0	641.9	3.0	0.0	4,258.7	0.0	-65	4,838.6	
Colorado	82.7	1,418.7	46.7	0.0	538.0	0.0	0	2,086.1	
Nevada	4.2	96.8	294.5	1.2	0.0	-3.0	-43.6	350.1	
New Mexico	44.3	190.5	52.0	0.9	54.6	0.0	0	342.3	
Utah	65.0	577.0	40.7	0.0	99.5	0.0	0	782.2	
Wyoming	41.6	241.7	50.7	0.0	7.0	0.0	0	341.0	
Other ⁴	1,598.4	0.0	0.0	0.0	3,996.4	0.0	0	5,594.8	
Colorado River System total	2,115.9	8,619.2	1,000.8	56.0	8,954.2	0.0	-243.6	20,502.5	

¹ From tables UC-1, UC-2, LC-1, and LC-2.

² Includes livestock water use and stockpond evaporation.

³ Includes water uses for thermal electric power generation and mineral resources.

⁴ Reservoir evaporation represents main stem reservoir evaporation in the Upper Basin and Lower Basin and main stem channel losses for Lower Basin. Exports outside system represent water passing to Mexico.

L.B. A2/Ca/11/4
11,356.1

Table C-3.--Summary of estimated water use by States and types of use
1982

State	Estimated beneficial consumptive uses and losses ¹							Unmeasured return flow	Total
	Reservoir evaporation	Irrigated agriculture ²	Municipal and industrial ³	Fish and wildlife recreation	Export outside system	Export within system	Unmeasured return flow		
Arizona	212.1	4,480.9	532.6	49.5	0.0	3.0	-135.4	5,142.7	
California	0.0	572.2	3.1	0.0	3,838.4	0.0	-64.6	4,349.1	
Colorado	78.4	1,378.5	44.5	0.0	604.7	0.0	0	2,106.1	
Nevada	3.9	97.4	301.9	1.0	0.0	-3.0	-49.2	352.0	
New Mexico	42.3	195.2	54.5	0.9	131.8	0.0	0	424.7	
Utah	59.4	569.6	41.2	0.0	75.5	0.0	0	745.7	
Wyoming	39.2	228.7	50.8	0.0	11.1	0.0	0	329.8	
Other ⁴	<u>1,402.9</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>1,816.8</u>	<u>0.0</u>	<u>0</u>	<u>3,219.7</u>	
Colorado River System total	1,838.2	7,522.5	1,028.6	51.4	6,478.3	0.0	-249.2	16,669.8	

¹ From tables UC-1, UC-3, LC-1, and LC-2.

² Includes livestock water use and stockpond evaporation.

³ Includes water uses for thermal electric power generation and mineral resources.

⁴ Reservoir evaporation represents main stem reservoir evaporation in the Upper Basin and Lower Basin and main stem channel losses for Lower Basin. Exports outside the system represents water passing to Mexico.

L.B.
9843.8

Table C-4.—Summary of estimated water use by States and types of use
1983

State	Estimated beneficial consumptive uses and losses ¹										Total
	Reservoir evaporation	Irrigated agriculture ²	Municipal and industrial ³	Fish and wildlife recreation ⁴	Export outside system	Export within system	Unmeasured return flow				
Arizona	280.4	3,548.2	517.2	30.6	0.0	3.0	-142.2				4,237.2
California	0.0	409.4	2.5	0.0	3,598.5	0.0	-57.8				3,952.6
Colorado	82.3	1,373.7	40.1	0.0	423.4	0.0	0				1,919.5
Nevada	4.6	91.2	311.6	1.1	0.0	-3.0	-66.2				339.3
New Mexico	39.0	198.8	55.6	0.9	131.2	0.0	0				425.5
Utah	63.0	587.1	43.1	0.0	24.9	0.0	0				718.1
Wyoming	36.7	257.6	45.2	0.0	6.6	0.0	0				346.1
Other ⁴	1,896.2	0.0	0.0	0.0	9,781.8	0.0	0				11,678.0
Colorado River System total	2,402.2	6,466.0	1,015.3	32.6	13,966.4	0.0	-266.2				23,616.3

¹ From tables UC-1, UC-4, LC-1, and LC-2.

² Includes livestock water use and stockpond evaporation.

³ Includes water uses for thermal electric power generation and mineral resources.

⁴ Reservoir evaporation represents main stem reservoir evaporation in the Upper Basin and Lower Basin and main stem channel losses for Lower Basin. Exports outside the system represents water passing to Mexico.

11,678.0

Table C-5.--Summary of estimated water use by States and types of use
1984

State	Estimated beneficial consumptive uses and losses ¹										Total
	Reservoir evaporation	Irrigated agriculture ²	Municipal and industrial ³	Fish and wildlife recreation	Export outside system	Export within system	Unmeasured return	flow	return	flow	
Arizona	274.5	4,344.9	555.7	5.8	0.0	3.0	-143				5,040.9
California	0.0	446.3	3.0	0.0	4,286.5	0.0	-57				4,678.8
Colorado	84.2	1,298.0	38.8	0.0	443.7	0.0	0				1,864.7
Nevada	5.1	95.4	323.6	1.0	0.0	-3.0	-66.9				355.2
New Mexico	44.9	199.7	58.0	0.9	114.1	0.0	0				417.6
Utah	64.7	630.0	44.0	0.0	23.3	0.0	0				762.0
Wyoming	34.5	229.4	39.4	0.0	4.0	0.0	0				307.3
Other ⁴	1,197.1	0.0	0.0	0.0	16,991.3	0.0	0				18,188.4
Colorado River System total	1,705.0	7,243.7	1,062.5	7.7	21,862.9	0.0	-266.9				31,614.9

¹ From tables UC-1, UC-5, LC-1, and LC-2.

² Includes livestock water use and stockpond evaporation.

³ Includes water uses for thermal electric power generation and mineral resources.

⁴ Reservoir evaporation represents main stem reservoir evaporation in the Upper Basin and Lower Basin and main stem channel losses for Lower Basin. Exports outside the system represents water passing to Mexico.

L.B. 10,100,000

Table C-6.-Summary of estimated water use by States and types of use
1985

State	Estimated beneficial consumptive uses and losses ¹										Total
	Reservoir evaporation	Irrigated agriculture	Municipal and industrial	Fish and wildlife recreation	Export outside system	Export within system	Unmeasured return flow				
Arizona	266.2	4,120.0	585.2	6.0	0.0	3.0	-142.3				4,838.1
California	0.0	455.9	3.3	0.0	4,308.6	0.0	-57.7				4,710.1
Colorado	86.3	1,359.4	38.5	0.0	509.6	0.0	0.0				1,993.8
Nevada	4.7	102.6	336.0	1.0	0.0	-3.0	-69.2				372.1
New Mexico	38.4	211.0	58.1	0.9	92.8	0.0	0				401.2
Utah	69.0	705.5	45.3	0.0	59.6	0.0	0				879.4
Wyoming	30.5	250.4	44.2	0.0	11.3	0.0	0				336.4
Other ²	1,782.9	0.0	0.0	0.0	13,395.9	0.0	0				15,178.8
Colorado River System total	2,278.0	7,204.8	1,110.6	7.9	18,377.8	0.0	-269.2				28,709.9

¹ From tables UC-1, UC-6, LC-1, and LC-2.

² Includes livestock water use and stockpond evaporation.

³ Includes water uses for thermal electric power generation and mineral resources.

⁴ Reservoir evaporation represents main stem reservoir evaporation in the Upper Basin and Lower Basin and main stem channel losses for Lower Basin. Exports outside the system represents water passing to Mexico.

AUG (1981-85) IIR, AG (CO) CU 1366, 1994 DEBITED CU
 AUG (1971-85) TOTAL CU (COLORADO) 504 AUG 19815 EXPORTS
 1490 IN-BASIN CU

Table UC-1.--Upper Colorado River Basin
Estimated main stem reservoir evaporation¹

1981-1985

Reservoir	Evaporation					Average
	1981	1982	1983	1984	1985	1981-1985
Flaming Gorge	74.2	72.5	81.1	81.4	82.2	78.3
Blue Mesa	8.2	9.0	12.4	9.1	9.7	9.7
Morrow Point	1.1	1.0	1.2	0.9	1.0	1.0
Lake Powell	<u>457.9</u>	<u>418.4</u>	<u>519.5</u>	<u>567.7</u>	<u>552.0</u>	<u>503.1</u>
Total	541.4	500.9	614.2	659.1	644.9	592.1

¹ Undistributed by States. Evaporation determined using average historical evaporation rates.

Table UC-2.—Upper Colorado River Basin
Estimated water use within States, by major tributaries, and types of use
1981

State	Tributary	(1,000 acre-feet)										
		Agriculture					Municipal & Industrial					
		Reservoir ¹ evaporation	Irrigation	Stockpond evaporation	livestock	Total	Mineral resources	Thermal electric power	Urban rural & industrial	Export Within system	Export	
Arizona	San Juan-Colo.	5.6	4.6	3.5	8.1	0.4	21.1	6.6	28.1	0.0	0.0	41.8
Colorado	Green River	6.5	154.9	3.7	158.6	4.0	12.7	1.9	18.6	0.0	0.0	183.7
	Upper Main Stem	67.4	1,059.4	7.4	1,056.9	9.9	0.1	13.1	23.1	535.2	120.9	1,813.4
	San Juan-Colo.	8.0	187.3	6.0	193.3	2.0	0.0	5.0	5.0	2.8	-120.9	89.0
	Subtotal	82.7	1,401.6	17.1	1,418.7	15.9	12.8	18.0	46.7	538.0	0.0	2,086.1
			1,554.5	17.1	1,571.5				66			2,147.5
New Mexico	San Juan-Colo.	39.3	175.7	3.9	179.6	4.2	28.1	9.5	41.8	53.9	0.0	314.6
Utah	Green River	51.3	409.1	4.8	413.9	6.8	20.1	5.6	32.5	103.8	0.0	601.5
	Upper Main Stem	0.4	9.1	0.1	9.2	1.6	0.0	0.9	2.5	0.0	0.0	12.1
	San Juan-Colo.	8.7	42.9	4.3	47.2	1.6	0.0	1.1	2.7	-5.7	0.0	52.9
	Subtotal	60.4	461.1	9.2	470.3	10.0	20.1	7.6	37.7	98.1	0.0	666.5
Wyoming	Green River	41.6	237.1	4.6	241.7	16.4	28.6	5.7	50.7	7.0	0.0	341.0
Upper Basin Totals	Green River	99.4	801.1	13.1	814.2	27.2	61.4	13.2	101.8	110.8	0.0	1,126.3
	Upper Main Stem	67.8	1,068.5	7.5	1,076.0	11.5	0.1	14.0	25.6	535.2	120.9	1,825.5
	San Juan-Colo.	62.4	405.9	17.7	423.6	8.2	49.2	28.2	77.6	51.0	-120.9	493.7
	Subtotal	229.6	2,275.5	38.3	2,313.8	46.9	110.7	47.4	205.0	697.0	0.0	3,445.4

¹ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table UC-1.

Table UC-3.--Upper Colorado River Basin
Estimated water use within States, by major tributaries, and types of use
1982

State	Tributary	(1,000 acre-feet)										
		Agriculture					Municipal & Industrial					
		Reservoir ¹ evaporation	Irrig- ation	Stock- pound evaporation	Total	Mineral resources	Thermal electric power	Urban rural & Industrial	Total	Export Outside system	Within system Totals	
Arizona	San Juan-Colo.	4.3	5.7	3.4	9.1	0.4	19.4	6.6	26.4	0.0	0.0	39.8
Colorado	Green River	6.5	140.8	3.6	144.4	3.1	13.2	1.9	18.2	0.0	0.0	169.1
	Upper Main Stem	63.2	1,016.9	7.2	1,024.1	7.7	0.2	13.8	21.7	601.7	156.1	1,866.8
	San Juan-Colo.	8.7	204.1	5.9	210.0	1.5	0.0	3.1	4.6	3.0	-156.1	70.2
	Subtotal	78.4	1,361.8	16.7	1,378.5	12.3	13.4	18.8	44.5	604.7	0.0	2,106.1
New Mexico	San Juan-Colo.	37.6	179.4	4.0	183.4	3.9	34.2	9.1	47.2	131.0	0.0	399.2
Utah	Green River	46.6	403.5	4.5	405.0	6.0	20.0	6.1	32.1	78.7	0.0	565.4
	Upper Main Stem	0.4	7.8	0.1	7.9	1.7	0.0	1.0	2.7	0.0	0.0	11.0
	San Juan-Colo.	8.1	46.8	4.2	51.0	2.0	0.0	1.2	3.2	-6.0	0.0	56.3
	Subtotal	55.1	458.1	8.8	466.9	9.7	20.0	8.3	38.0	72.7	0.0	632.7
Wyoming	Green River	39.2	224.3	4.4	228.7	13.9	31.0	5.9	50.8	11.1	0.0	329.8
Upper Basin Totals	Green River	92.3	768.6	12.5	781.1	23.0	64.2	13.9	101.1	89.8	0.0	1,064.3
	Upper Main Stem	63.6	1,024.7	7.3	1,032.0	9.4	0.2	14.8	24.4	601.7	156.1	1,877.8
	San Juan-Colo.	58.7	430.3	17.5	447.8	7.8	53.6	20.0	81.4	128.0	-156.1	559.8
	Subtotal	214.6	2,223.6	37.3	2,260.9	40.2	118.0	48.7	206.9	819.5	0.0	3,501.9

¹ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table UC-1.

Table UC-4.—Upper Colorado River Basin
Estimated water use within States, by major tributaries, and types of use
1983

State	Tributary	(1,000 acre-feet)										
		Reservoir ¹ Evaporation	Agriculture		Municipal & Industrial				Export		Totals	
			Irrigation & Livestock	Stockpond Evaporation	Mineral Resources	Thermal Electric Power	Urban Rural & Industrial	Total	System	Outside System		
Arizona	San Juan-Colo.	4.0	6.5	3.5	10.0	0.4	20.2	7.0	27.6	0.0	0.0	41.6
Colorado	Green River	6.5	138.2	3.6	141.8	2.2	11.8	1.9	15.9	0.0	0.0	164.2
	Upper Main Stem	67.2	1,009.5	7.2	1,016.7	5.2	0.2	14.6	20.0	420.0	123.5	1,647.4
	San Juan-Colo.	8.6	209.3	5.9	215.2	1.0	0.0	3.2	4.7	3.4	-123.5	107.9
	Subtotal	82.3	1,357.0	16.7	1,373.7	8.4	12.0	19.7	40.7	423.4	0.0	1,919.5
			1,496.2	16.6	1,512.8				24.6			2,444.1
New Mexico	San Juan-Colo.	34.3	185.2	4.0	189.2	5.4	33.2	8.5	47.1	130.3	0.0	400.9
Utah	Green River	49.2	407.3	4.5	411.8	5.2	21.4	6.6	33.2	20.0	0.0	514.2
	Upper Main Stem	0.4	9.1	0.1	9.2	1.8	0.0	1.1	2.9	0.0	0.0	12.5
	San Juan-Colo.	8.3	58.8	4.2	63.0	2.4	0.0	1.2	3.6	-5.1	0.0	69.8
	Subtotal	57.9	475.2	8.8	484.0	9.4	21.4	8.9	39.7	14.9	0.0	596.5
Wyoming	Green River	36.7	253.2	4.4	257.6	11.3	27.7	6.2	45.2	6.6	0.0	346.1
Upper Basin Totals	Green River	92.4	798.7	12.5	811.2	18.7	60.9	14.7	94.3	26.6	0.0	1,024.5
	Upper Main Stem	67.6	1,018.6	7.3	1,025.9	7.0	0.2	15.7	22.9	420.0	123.5	1,659.9
	San Juan-Colo.	55.2	459.8	17.6	477.4	9.2	53.4	19.9	82.5	128.5	-123.5	620.2
	Subtotal	215.2	2,277.1	37.4	2,314.5	34.9	114.5	50.3	199.7	575.2	0.0	3,304.6

¹ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table UC-1.

Table UC-5.--Upper Colorado River Basin
Estimated water use within States, by major tributaries, and types of use
1984

State	Tributary	(1,000 acre-feet)										
		Agriculture				Municipal & industrial						
		Reservoir ¹ evaporation	Irrig- ation	Stock- pond evaporation	Total	Mineral resources	Thermal electric power	Urban rural & industrial	Total	Export Outside system	Within system	Totals
Arizona	San Juan-Colo.	4.9	5.8	3.3	9.1	0.4	22.1	7.5	30.0	0.0	0.0	44.0
Colorado	Green River	6.5	134.7	3.6	138.3	1.3	13.1	1.9	16.3	0.0	0.0	161.1
	Upper Main Stem	69.0	922.5	7.2	929.7	3.2	0.0	15.4	18.6	440.0	137.7	1,595.0
	San Juan-Colo.	8.7	224.1	5.9	236.0	0.6	0.0	3.3	2.9	3.7	-137.7	108.6
	Subtotal	84.2	1,281.3	16.7	1,298.0	5.1	13.1	20.6	38.8	443.7	0.0	1,864.7
		3	1,290.3	16.8	1,407.1							
New Mexico	San Juan-Colo.	40.1	186.7	4.0	190.7	4.2	37.7	8.2	50.1	113.6	0.0	394.5
Utah	Green River	50.3	438.7	4.4	443.1	4.4	21.9	7.0	33.3	26.8	0.0	553.5
	Upper Main Stem	0.4	10.1	0.1	10.2	1.8	0.0	1.2	3.0	0.0	0.0	13.6
	San Juan-Colo.	8.4	60.3	4.3	64.6	2.8	0.0	1.3	4.1	-6.1	0.0	71.0
	Subtotal	59.1	509.1	8.8	517.9	9.0	21.9	9.5	40.4	20.7	0.0	638.1
Wyoming	Green River	34.5	225.2	4.2	229.4	8.7	24.3	6.4	39.4	4.0	0.0	307.3
Upper Basin Totals	Green River	91.3	798.6	12.2	810.8	14.4	59.3	15.3	89.0	30.8	0.0	1,021.9
	Upper Main Stem	69.4	932.6	7.3	939.9	5.0	0.0	16.6	21.6	440.0	137.7	1,608.6
	San Juan-Colo.	62.1	476.9	17.5	494.4	8.0	59.8	20.3	88.1	111.2	-137.7	618.1
	Subtotal	222.8	2,208.1	37.0	2,245.1	27.4	119.1	52.2	198.7	582.0	0.0	3,248.6

¹ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table UC-1.

Table UC-6.—Upper Colorado River Basin
Estimated water use within States, by major tributaries, and types of use
1985

State	Tributary	(1,000 acre-feet)										
		Agriculture					Municipal & industrial					
		Reservoir ¹ evaporation	Irrigation	Stockpond evaporation & livestock	Total	Mineral resources	Thermal electric power	Urban rural & industrial	Export	Outside system	Within system	Totals
Arizona	San Juan-Colo.	4.9	5.8	2.5	8.3	0.4	23.2	7.2	30.8	0.0	0.0	44.0
Colorado	Green River	6.5	129.8	3.5	133.3	0.3	15.6	1.9	17.8	0.0	0.0	157.6
	Upper Main Stem	71.1	1,011.3	7.0	1,018.3	0.9	0.0	16.2	17.1	505.3	140.7	1,752.5
	San Juan-Colo.	8.7	202.0	5.8	207.8	0.2	0.0	3.4	3.6	4.3	-140.7	83.7
	Subtotal	86.3	1,343.1	16.3	1,359.4	1.4	15.6	21.5	38.5	509.6	0.0	1,993.8
			1,761.9		1,776.2							2,112.5
New Mexico	San Juan-Colo.	33.2	198.6	4.0	202.6	5.6	34.0	7.9	47.5	91.8	0.0	375.1
Utah	Green River	55.3	510.7	4.4	515.1	3.5	22.6	7.5	33.6	63.6	0.0	667.6
	Upper Main Stem	0.4	9.6	0.1	9.7	1.9	0.0	1.3	3.2	0.0	0.0	13.3
	San Juan-Colo.	8.1	63.5	4.0	67.5	3.3	0.0	1.3	4.6	-6.1	0.0	74.1
	Subtotal	63.8	583.8	8.5	592.3	8.7	22.6	10.1	41.4	57.5	0.0	755.0
Wyoming	Green River	30.5	245.9	4.5	250.4	6.2	31.3	6.7	44.2	11.3	0.0	336.4
Upper Basin Totals	Green River	92.3	886.4	12.4	898.8	10.0	69.5	16.1	95.6	74.9	0.0	1,161.6
	Upper Main Stem	71.5	1,020.9	7.1	1,028.0	2.8	0.0	17.5	20.3	505.3	140.7	1,765.8
	San Juan-Colo.	54.9	469.9	16.3	486.2	9.5	57.2	19.8	86.5	90.0	-140.7	576.9
	Subtotal	218.7	2,377.2	35.8	2,413.0	22.3	126.7	53.4	202.4	670.2	0.0	3,504.3

¹ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table UC-1.

Table UC-7.--Upper Colorado River Basin
Irrigated acreage
1981-1985

State	Tributary	(1,000 acres)				
		Irrigated acreage				
		1981	1982	1983	1984	1985
Arizona	San Juan-Colo.	5.4	5.4	5.4	3.5	3.6
Colorado	Green River	118.7	107.5	109.3	107.5	101.2
	Upper Main Stem	575.6	556.5	563.5	527.7	528.9
	San Juan-Colo.	<u>142.4</u>	<u>147.3</u>	<u>145.9</u>	<u>141.0</u>	<u>137.6</u>
	State total	<u>836.1</u>	<u>811.3</u>	<u>818.7</u>	<u>776.2</u>	<u>767.7</u>
		837.3	812.4	821.0	777.1	768.9
New Mexico	San Juan-Colo.	93.8	95.4	93.5	89.9	92.9
Utah	Green River	210.9	209.1	215.5	224.0	235.6
	Upper Main Stem	4.4	4.4	4.4	4.5	5.0
	San Juan-Colo.	<u>34.8</u>	<u>32.5</u>	<u>33.7</u>	<u>35.9</u>	<u>36.4</u>
	State total	<u>250.1</u>	<u>246.0</u>	<u>253.6</u>	<u>264.4</u>	<u>277.0</u>
Wyoming	Green River	250.0	234.1	278.7	236.6	246.7
Upper Basin	Green River	579.0	550.7	603.5	568.1	583.5
	Upper Main Stem	580.0	560.9	567.9	532.2	533.9
	San Juan-Colo.	<u>276.4</u>	<u>280.6</u>	<u>278.5</u>	<u>270.3</u>	<u>270.5</u>
	Total	<u>1,435</u>	<u>1,392</u>	<u>1,450</u>	<u>1,371</u>	<u>1,388</u>

**Table UC-8.--Upper Colorado River Basin
Population estimates
1981-1985**

State	Tributary	(1,000's)				
		Estimated population				
		1981	1982	1983	1984	1985
Arizona	San Juan-Colo.	41.3	42.3	43.2	44.2	45.1
Colorado	Green River	32.8	32.9	33.0	33.1	33.2
	Upper Main Stem	213.6	219.3	225.0	230.7	236.4
	San Juan-Colo.	<u>49.4</u>	<u>50.6</u>	<u>51.8</u>	<u>53.1</u>	<u>54.3</u>
	State total	295.8	302.8	309.8	316.9	323.9
New Mexico	San Juan River	99.6	102.5	105.4	108.3	108.1
Utah	Green River	68.7	70.1	71.5	73.0	74.4
	Upper Main Stem	8.0	7.8	7.5	7.3	7.1
	San Juan-Colo.	<u>16.5</u>	<u>16.6</u>	<u>16.7</u>	<u>16.9</u>	<u>17.0</u>
	State total	93.2	94.5	95.7	97.2	98.5
Wyoming	Green River	58.7	61.4	64.1	66.8	69.4
Upper Basin	Green River	160.2	164.4	168.6	172.9	177.0
	Upper Main Stem	221.6	227.1	232.5	238.0	243.5
	San Juan-Colo.	<u>206.8</u>	<u>212.0</u>	<u>217.1</u>	<u>222.5</u>	<u>224.5</u>
	Total	588.6	603.5	618.2	633.4	645.0

Table LC-1.--Lower Colorado River Basin
 Colorado River main stem estimated reservoir evaporation and channel loss¹
 1981-1985

Water Year	(1,000 acre-feet)										
	Reservoir evaporation				Reservoir evaporation and channel loss		Apparent channel losses ¹			Total	Total reservoir evaporation and channel loss
	Lake Head	Lake Mohave	Lake Havasu	Senator Wash Reservoir	Other ²	Total	Lee Ferry to Hoover Dam	Hoover Dam to IB	Total		
1981	722	139	106	2	38	1,007	130	(-80)	50	1,057	
1982	716	131	99	2	34	982	(-50)	(-30)	(-80)	902	
1983	833	133	100	2	34	1,102	(-100)	280	180	1,282	
1984	734	128	99	2	35	998	(-350)	(-110)	(-460)	538	
1985	<u>793</u>	<u>138</u>	<u>100</u>	<u>2</u>	<u>35</u>	<u>1,068</u>	<u>(-10)</u>	<u>80</u>	<u>70</u>	<u>1,138</u>	
Average	759	134	101	2	35	1,031	(-76)	28	(-48)	983	

¹ Undistributed by States.

² "Other" impoundments include Palo Verde, Headgate Rock, Imperial, Laguna, and Morelos Diversion Dams.

³ Losses include channel evaporation, seepage, and phreatophyte consumptive use. Note that gauge error of a USGS "excellent" gauge is 5 percent, or approximately 400,000 acre-feet per year for the gauges at Lee Ferry, Hoover Dam, and the International Border. Such gauge errors may result in the computation of large apparent channel losses.

Table LC-2.—Lower Colorado River Basin
Estimated water use including Colorado main stem by States and types of use¹
1981-1985

Water year	State	(1,000 acre-feet)											
		Reservoir evaporation	Irrigation	Agriculture Stockpond evaporation and livestock	Total	Mineral resources	Thermal electric power	Other ²	Total	Fish, wild-life, and recreation	Export Outside system	Export Inside system	Total
1981	Arizona	274.1	5,395.9	48.6	5,444.5	61.4	38.4	385.3	485.1	53.9	0.0	3.0	6,260.6
	Nevada	4.2	95.1	1.7	96.8	3.5	22.7	268.3	294.5	1.2	0.0	-3.0	393.7
	New Mexico	5.0	8.9	2.9	11.8	7.6	0.0	2.6	10.2	0.0	0.7	0.0	27.7
	Utah	4.6	105.4	1.3	106.7	0.0	0.0	3.0	3.0	0.0	1.4	0.0	115.7
	California	0.0	641.9	0.0	641.9	0.0	0.0	3.0	3.0	0.0	4,258.7	0.0	4,903.6
	Total	287.9	6,247.2	54.5	6,301.7	72.5	61.1	662.2	795.8	55.1	0.0	0.0	11,701.3
1982	Arizona	207.8	4,429.5	42.3	4,471.8	79.3	32.2	394.7	506.2	49.5	0.0	3.0	5,238.3
	Nevada	3.9	95.8	1.6	97.4	2.4	28.0	271.5	301.9	1.0	0.0	-3.0	401.2
	New Mexico	4.7	9.5	3.2	12.7	4.7	0.0	2.6	7.3	0.0	0.8	0.0	25.5
	Utah	4.3	101.5	1.2	102.7	0.0	0.0	3.2	3.2	0.0	2.8	0.0	113.0
	California	0.0	572.2	0.0	572.2	0.0	0.0	3.1	3.1	0.0	3,838.4	0.0	4,413.7
	Total	220.7	5,208.5	48.3	5,256.8	86.4	60.2	675.1	821.7	50.5	0.0	0.0	10,191.7
1983	Arizona	276.4	3,498.7	39.5	3,538.2	54.1	25.8	409.7	489.6	30.6	0.0	3.0	4,337.9
	Nevada	4.6	89.5	1.7	91.2	2.3	25.7	283.6	311.6	1.1	0.0	-3.0	405.5
	New Mexico	4.7	7.4	3.1	10.5	5.8	0.0	2.7	8.5	0.0	0.9	0.0	24.6
	Utah	5.1	101.8	1.3	103.1	0.0	0.0	3.4	3.4	0.0	10.0	0.0	121.6
	California	0.0	409.4	0.0	409.4	0.0	0.0	2.5	2.5	0.0	3,598.5	0.0	4,010.4
	Total	290.8	4,106.8	45.6	4,152.4	62.3	51.5	700.8	814.6	31.7	0.0	0.0	8,898.9
1984	Arizona	269.6	4,297.8	38.0	4,335.8	59.9	33.0	432.8	525.7	5.8	0.0	3.0	5,139.9
	Nevada	5.1	93.6	1.8	95.4	2.3	26.3	295.0	323.6	1.0	0.0	-3.0	422.1
	New Mexico	4.8	6.7	3.2	9.9	5.3	0.0	2.6	7.9	0.0	0.5	0.0	23.1
	Utah	5.6	110.8	1.3	112.1	0.0	0.0	3.6	3.6	0.0	2.6	0.0	123.9
	California	0.0	445.3	0.0	445.3	0.0	0.0	3.0	3.0	0.0	4,286.5	0.0	4,735.8
	Total	285.1	4,955.2	44.3	4,999.5	67.5	59.3	737.0	863.8	6.8	0.0	0.0	10,444.8
1985	Arizona	261.3	4,065.7	46.0	4,111.7	62.9	34.7	456.8	554.4	6.0	0.0	3.0	4,936.4
	Nevada	4.7	100.9	1.7	102.6	2.3	19.8	313.9	336.0	1.0	0.0	-3.0	441.3
	New Mexico	5.2	6.4	2.9	9.3	7.8	0.0	2.8	10.6	0.0	1.0	0.0	26.1
	Utah	5.2	111.9	1.3	113.2	0.0	0.0	3.9	3.9	0.0	2.1	0.0	124.4
	California	0.0	455.9	0.0	455.9	0.0	0.0	3.3	3.3	0.0	4,308.6	0.0	4,767.8
	Total	276.4	4,740.8	51.9	4,792.7	73.0	54.5	780.7	908.2	7.0	0.0	0.0	10,296.0

¹ A portion of the consumptive uses shown herein is satisfied by ground-water overdraft. Table does not include Colorado main stem unmeasured return flow.
² Includes rural, urban, and other industrial uses.

Table LC-3.--Lower Colorado River Basin
Colorado main stem water use and exports within States and Mexico¹
1981-1985

Water Year	State	Estimated consumptive use ²										Unmeasured		Water passing to Mexico ³	
		Irrigated agriculture	Municipal Industrial	Thermal power & elec.	Fish & wildlife	Export	Total	Return flow ⁴	Adjusted total	Treaty	Minute 242	Excess releases	Total	Water passing to Mexico ³	
														Excess releases	Total
1981	Nevada	0.0	139.7	12.1	1.2	0.0	153.0	43.6	109.4	-	-	-	-	-	-
	Arizona	1,348.1	14.6	0.8	53.9	0.0	1,417.4	135.0	1,282.4	-	-	-	-	-	-
	California	641.9	3.0	0.0	0.0	4,258.7	4,903.6	65.0	4,838.6	-	-	-	-	-	-
	Total	1,990.0	157.3	12.9	55.1	4,258.7	6,474.0	243.6	6,230.4	1,750.8	130.6	2,114.8	3,996.4	-	-
1982	Nevada	0.0	137.3	16.8	1.0	0.0	155.1	49.2	105.9	-	-	-	-	-	-
	Arizona	1,198.9	13.4	0.6	49.5	0.0	1,262.4	135.4	1,127.0	-	-	-	-	-	-
	California	572.2	3.1	0.0	0.0	3,838.4	4,413.7	64.6	4,349.1	-	-	-	-	-	-
	Total	1,771.1	153.8	17.4	50.5	3,838.4	5,831.2	249.2	5,582.0	1,494.8	146.2	175.8	1,816.8	-	-
1983	Nevada	0.0	141.7	15.5	1.1	0.0	158.3	66.2	92.1	-	-	-	-	-	-
	Arizona	1,007.4	13.1	0.7	30.6	0.0	1,051.8	142.2	909.6	-	-	-	-	-	-
	California	409.4	2.5	0.0	0.0	3,598.5	4,010.4	57.8	3,952.6	-	-	-	-	-	-
	Total	1,416.8	157.3	16.2	31.7	3,598.5	5,220.5	266.2	4,954.3	1,646.3	166.0	7,969.5	9,781.8	-	-
1984	Nevada	0.0	148.9	16.1	1.0	0.0	166.0	66.9	99.1	-	-	-	-	-	-
	Arizona	1,120.8	14.3	0.7	5.8	0.0	1,141.6	143.0	998.6	-	-	-	-	-	-
	California	446.3	3.0	0.0	0.0	4,286.5	4,735.8	57.0	4,678.8	-	-	-	-	-	-
	Total	1,567.1	166.2	16.8	6.8	4,286.5	6,043.4	266.9	5,776.5	1,693.6	137.8	15,159.9	16,991.3	-	-
1985	Nevada	0.0	163.3	7.4	1.0	0.0	171.7	69.2	102.5	-	-	-	-	-	-
	Arizona	1,123.8	14.9	0.5	6.0	29.3	1,174.5	142.3	1,032.2	-	-	-	-	-	-
	California	455.9	3.3	0.0	0.0	4,308.6	4,767.8	57.7	4,710.1	-	-	-	-	-	-
	Total	1,579.7	181.5	7.9	7.0	4,337.9	6,114.0	269.2	5,844.8	1,670.9	130.8	11,594.2	13,395.9	-	-

¹ From the Bureau of Reclamation calendar year reports "Compilation of Records in Accordance with Article V of the Decree of the Supreme Court of the United States in Arizona vs. California dated March 9, 1965." Exports to California and water passing to Mexico are demands on system water and consumption is outside the system.

² Source: International Boundary and Water Commission.

³ Estimates of unmeasured return flows are for the Colorado River diversions portions of Las Vegas Wash (Nevada) surface water discharge to Lake Mead, as found in decree accounting. Total unmeasured return flows for Arizona and California are estimated to be 200,000 acre-feet which is proportioned on the basis of irrigated agriculture diversions.

⁴ Central Arizona Project.

Table LC-4.--Lower Colorado River Basin
 Estimated water use within States, by major tributaries, and types of use¹
 1981

State	Tributary	Reservoir ² evaporation	Agriculture			Municipal and Industrial			(1,000 acre-feet)			
			Stockpond evaporation and livestock		Mineral resources	Thermal electric power	Other ³	Total	Outside system	Inside system	Total	
			Irrigation	Total								Total
Arizona	Little Colorado	14.9	103.2	5.5	108.7	3.1	20.9	8.5	32.5	0.0	+11.1	167.2
	Virgin	0.3	23.4	0.3	23.7	0.0	0.0	0.5	0.5	0.0	0.0	24.5
	Bill Williams	22.0	37.5	1.2	38.7	1.7	0.0	1.7	3.4	0.0	0.0	64.1
	Gila	236.3	3,723.0	32.5	3,755.5	54.8	16.7	336.0	407.5	0.0	-8.1	4,391.2
	Remaining area	0.6	160.7	9.1	169.8	1.8	0.0	24.0	25.8	0.0	0.0	196.2
Total	274.1	4,047.8	48.6	4,096.4	61.4	37.6	370.7	469.7	0.0	+3.0	4,843.2	
Nevada	Muddy	4.2	36.0	0.7	36.7	0.6	4.4	0.2	5.2	0.0	0.0	46.1
	Remaining area	0.0	59.1	1.0	60.1	2.9	6.2	128.4	137.5	0.0	-3.0	194.6
Total	4.2	95.1	1.7	96.8	3.5	10.6	128.6	142.7	0.0	-3.0	240.7	
N. Mex.	Little Colorado	4.4	1.7	0.7	2.4	1.2	0.0	2.4	3.6	0.0	0.0	10.4
	Gila	0.6	7.2	2.2	9.4	36.4	0.0	0.2	6.6	0.7	0.0	17.3
	Total	5.0	8.9	2.9	11.8	7.6	0.0	2.6	10.2	0.7	0.0	27.7
Utah	Virgin	4.5	95.3	1.1	96.4	0.0	0.0	2.9	2.9	1.4	0.0	105.2
	Remaining area	0.1	10.1	0.2	10.3	0.0	0.0	0.1	0.1	0.0	0.0	10.5
Total	4.6	105.4	1.3	106.7	0.0	0.0	3.0	3.0	1.4	0.0	115.7	
Lower Basin	Little Colorado	19.3	104.9	6.2	111.1	4.3	20.9	10.9	36.1	0.0	11.1	177.6
	Virgin	4.8	118.7	1.4	120.1	0.0	0.0	3.4	3.4	1.4	0.0	129.7
	Muddy	4.2	36.0	0.7	36.7	0.6	4.4	0.2	5.2	0.0	0.0	46.1
	Bill Williams	22.0	37.5	1.2	38.7	1.7	0.0	1.7	3.4	0.0	0.0	64.1
	Gila	236.9	3,730.2	34.7	3,764.9	61.2	16.7	336.2	414.1	0.7	-8.1	4,408.5
Remaining area	0.7	229.9	10.3	240.2	4.7	6.2	132.5	163.4	0.0	-3.0	401.3	
Total	287.9	4,257.2	54.5	4,311.7	72.5	48.2	504.9	625.6	2.1	0.0	5,227.3	

¹ Excludes Colorado River main stem and flood plain. A portion of the consumptive uses shown herein are satisfied by ground-water overdraft.

² Includes rural, urban, and other industrial uses.

³ This value is included in the "Other" Municipal and Industrial Uses category, as listed in the annual report by the New Mexico Interstate Stream Commission as required by the Supreme Court decree in Arizona vs. California.

⁴ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table LC-1.

Table LC-5.-Lower Colorado River Basin
Estimated water use within States, by major tributaries, and types of use¹
1982

State	Tributary	(1,000 acre-feet)										
		Reservoir ⁴			Agriculture		Municipal and Industrial				Export	
		evaporation	Irrigation	Stockpond evap. and livestock	Mineral resources	Municipal	Thermal electric	power	Other ³	Total	Outside system	Inside system
Arizona	Little Colorado	11.2	93.2	4.4	97.6	2.2	22.3	8.6	33.1	0.0	+14.2	156.1
	Virgin	0.2	22.0	0.3	22.3	0.0	0.0	0.5	0.5	0.0	0.0	23.0
	Bill Williams	18.3	29.7	1.0	30.7	2.3	0.0	1.7	4.0	0.0	0.0	53.0
	Gila	177.6	2,952.8	28.4	2,981.2	72.6	9.3	346.5	428.4	0.0	-11.2	3,576.0
	Remaining area	0.5	132.9	8.2	141.1	2.2	0.0	24.0	25.2	0.0	0.0	167.8
Total	207.8	3,230.6	42.3	3,272.9	79.3	31.6	381.3	492.2	0.0	3.0	3,975.9	
Nevada	Muddy	3.9	32.0	0.6	32.6	0.6	7.0	0.1	7.7	0.0	0.0	44.2
	Remaining area	0.0	63.8	1.0	64.8	1.8	4.2	134.1	140.1	0.0	-3.0	201.9
	Total	3.9	95.8	1.6	97.4	2.4	11.2	134.2	147.8	0.0	-3.0	246.1
New Mexico	Little Colorado	4.2	2.3	0.8	3.1	1.2	0.0	2.4	3.6	0.0	0.0	10.9
	Gila	0.5	7.2	2.4	9.6	3.5	0.0	0.2	3.7	0.8	0.0	14.6
	Total	4.7	9.5	3.2	12.7	4.7	0.0	2.6	7.3	0.8	0.0	25.5
Utah	Virgin	4.2	92.4	1.0	93.4	0.0	0.0	3.1	3.1	2.8	0.0	103.5
	Remaining area	0.1	9.1	0.2	9.3	0.0	0.0	0.1	0.1	0.0	0.0	9.5
	Total	4.3	101.5	1.2	102.7	0.0	0.0	3.2	3.2	2.8	0.0	113.0
Lower Basin	Little Colorado	15.4	95.5	5.2	100.7	3.4	22.3	11.0	36.7	0.0	14.2	167.0
	Virgin	4.4	114.4	1.3	115.7	0.0	0.0	3.6	3.6	2.8	0.0	126.5
	Muddy	3.9	32.0	0.6	32.6	0.6	7.0	0.1	7.7	0.0	0.0	44.2
	Bill Williams	18.3	29.7	1.0	30.7	2.3	0.0	1.7	4.0	0.0	0.0	53.0
	Gila	178.1	2,960.0	30.8	2,990.8	76.1	9.3	346.7	432.1	0.8	-11.2	3590.6
Total	220.7	3,437.4	48.3	3,485.7	86.4	42.8	521.3	650.5	3.6	0.0	4,360.5	

¹ Excludes Colorado River main stem and flood plain. A portion of the consumptive uses shown herein are satisfied by ground-water overdraft.

² Includes rural, urban, and other industrial uses.

³ This value is included in the "Other" Municipal and Industrial Uses category, as listed in the annual report by the New Mexico Interstate Stream Commission as required by the Supreme Court decree in Arizona vs. California.

⁴ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table LC-1.

Table LC-6.—Lower Colorado River Basin
Estimated water use within States, by major tributaries, and types of use¹
1983

State	Tributary	Reservoir ⁴ evaporation	Agriculture				Municipal and industrial				Export		Total
			Irrigation	Stockpond evap. and livestock	Total	Mineral resources	Thermal electric power	Other ³	Total	Outside system	Inside system		
												Total	
Arizona	Little Colorado	11.5	89.1	4.4	93.5	2.7	19.0	9.0	30.7	0.0	16.5	152.2	
	Virgin	0.3	20.5	0.3	20.8	0.0	0.0	0.5	0.5	0.0	0.0	21.6	
	Bill Williams	23.7	27.9	1.0	28.9	1.5	0.0	1.8	3.3	0.0	0.0	55.9	
	Gila	240.4	2,240.8	25.8	2,266.6	48.2	6.1	361.2	415.5	0.0	-13.5	2,909.0	
	Remaining area	0.5	113.0	8.0	121.0	1.7	0.0	24.1	25.8	0.0	0.0	147.3	
Total	276.4	2,491.3	39.5	2,530.8	54.1	25.1	396.6	475.8	0.0	3.0	3,286.0		
Nevada	Muddy	4.6	32.7	0.7	33.4	0.6	6.8	0.1	7.5	0.0	0.0	45.5	
	Remaining area	0.0	56.8	1.0	57.8	1.7	3.4	141.8	146.9	0.0	-3.0	201.7	
	Total	4.6	89.5	1.7	91.2	2.3	10.2	141.9	154.4	0.0	-3.0	247.2	
New Mexico	Little Colorado	4.2	1.7	0.8	2.5	1.2	0.0	2.4	3.6	0.0	0.0	10.3	
	Gila	0.5	5.7	2.3	8.0	4.6	0.0	0.3	4.9	0.9	0.0	14.3	
	Total	4.7	7.4	3.1	10.5	5.8	0.0	2.7	8.5	0.9	0.0	24.6	
Utah	Virgin	4.9	92.8	1.1	93.9	0.0	0.0	3.3	3.3	10.0	0.0	112.1	
	Remaining area	0.2	9.0	0.2	9.2	0.0	0.0	0.1	0.1	0.0	0.0	9.5	
	Total	5.1	101.8	1.3	103.1	0.0	0.0	3.4	3.4	10.0	0.0	121.6	
Lower Basin	Little Colorado	15.7	90.8	5.2	96.0	3.9	19.0	11.4	34.3	0.0	16.5	162.5	
	Virgin	5.2	113.3	1.4	114.7	0.0	0.0	3.8	3.8	10.0	0.0	133.7	
	Muddy	4.6	32.7	0.7	33.4	0.6	6.8	0.1	7.5	0.0	0.0	45.5	
	Bill Williams	23.7	27.9	1.0	28.9	1.5	0.0	1.8	3.3	0.0	0.0	55.9	
	Gila	240.9	2,246.5	28.1	2,274.6	52.8	6.1	361.5	420.4	0.9	-13.5	2,923.3	
	Remaining area	0.7	178.8	9.2	188.0	3.4	3.4	166.0	172.8	0.0	-3.0	358.5	
Total	290.8	2,690.0	45.6	2,735.6	62.2	35.3	544.6	642.1	10.9	0.0	3,679.4		

¹ A portion of the consumptive uses shown herein are satisfied by ground-water overdraft.

² Includes rural, urban, and other industrial uses.

³ This value is included in the "Other" Municipal and Industrial Uses category, as listed in the annual report by the New Mexico Interstate Stream Commission as required by the Supreme Court decree in Arizona vs. California.

⁴ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table LC-1.

**Table LC-7.--Lower Colorado River Basin
Estimated water use within States, by major tributaries, and types of use¹
1984**

State	Tributary	Reservoir ⁴ evaporation	Agriculture		Municipal and Industrial				Export		Total	
			Irrigation	Stockpond evap. and livestock	Mineral resources	Thermal electric power	Other ²	Total system	Outside system	Inside		
												Total
Arizona	Little Colorado	10.4	99.5	4.1	103.6	3.2	21.9	9.3	34.4	0.0	17.6	166.0
	Virgin	0.2	21.8	0.3	22.1	0.0	0.0	0.5	0.5	0.0	0.0	22.8
	Bill Williams	24.1	27.1	1.1	28.2	1.6	0.0	1.6	3.2	0.0	0.0	55.5
	Gila	234.5	2,901.8	24.2	2,926.0	53.3	10.4	381.9	445.6	0.0	-14.6	3,591.5
	Remaining area	0.4	126.8	8.3	135.1	1.8	0.0	25.2	27.0	0.0	0.0	162.5
	Total	269.6	3,177.0	38.0	3,215.0	59.9	32.3	418.5	510.7	0.0	3.0	3,998.3
Nevada	Muddy	5.1	35.4	0.8	36.2	0.6	6.8	0.3	7.7	0.0	0.0	49.0
	Remaining area	0.0	58.2	1.0	59.2	1.7	3.4	145.8	150.9	0.0	-3.0	207.1
	Total	5.1	93.6	1.8	95.4	2.3	10.2	146.1	158.6	0.0	-3.0	256.1
New Mexico	Little Colorado	4.3	1.6	0.8	2.4	1.2	0.0	2.4	3.6	0.0	0.0	10.3
	Gila	0.5	5.1	2.4	7.5	4.1	0.0	0.2	4.3	0.5	0.0	12.8
	Total	4.8	6.7	3.2	9.9	5.3	0.0	2.6	7.9	0.5	0.0	23.1
Utah	Virgin	5.4	101.4	1.1	102.5	0.0	0.0	3.5	3.5	2.6	0.0	114.0
	Remaining area	0.2	9.4	0.2	9.6	0.0	0.0	0.1	0.1	0.0	0.0	9.9
	Total	5.6	110.8	1.3	112.1	0.0	0.0	3.6	3.6	2.6	0.0	123.9
Lower Basin	Little Colorado	14.7	101.1	4.9	106.0	4.4	21.9	11.7	38.0	0.0	17.6	176.3
	Virgin	5.6	123.2	1.4	124.6	0.0	0.0	4.0	4.0	2.6	0.0	136.8
	Muddy	5.1	35.4	0.8	36.2	0.6	6.8	0.3	7.7	0.0	0.0	49.0
	Bill Williams	24.1	27.1	1.1	28.2	1.6	0.0	1.6	3.2	0.0	0.0	55.5
	Gila	235.0	2,906.9	26.6	2,933.5	57.4	10.4	382.1	449.9	0.5	-14.6	3,604.3
	Remaining area	0.6	194.4	9.5	203.9	3.5	3.4	171.1	178.0	0.0	-3.0	379.5
	Total	285.1	3,388.1	44.3	3,432.4	67.5	42.5	570.8	680.8	3.1	0.0	4,401.4

¹ A portion of the consumptive uses shown herein are satisfied by ground-water overdraft.

² Includes rural, urban, and other industrial uses.

³ This value is included in the "Other" Municipal and Industrial Uses category, as listed in the annual report by the New Mexico Interstate Stream Commission as required by the Supreme Court decree in Arizona vs. California.

⁴ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table LC-1.

Table LC-8.--Lower Colorado River Basin
Estimated water use within States, by major tributaries, and types of use¹
1985

State	Tributary	Reservoir ⁴ evaporation	Agriculture			Municipal and industrial				Export		Total
			Irrigation	Stockpond evap. and livestock	Total	Mineral resources	Thermal electric power	Other ²	Total	Outside system	Inside system	
Arizona	Little Colorado	13.6	88.0	5.2	93.2	2.4	22.5	9.8	34.7	0.0	11.4	152.9
	Virgin	0.3	19.9	0.3	20.2	0.0	0.0	0.5	0.5	0.0	0.0	21.0
	Bill Williams	25.8	24.2	1.1	25.3	1.7	0.0	1.8	3.5	0.0	0.0	54.6
	Gila	221.0	2,686.6	30.8	2,717.4	56.8	11.7	404.4	472.9	0.0	-37.7	3,373.6
	Remaining area	0.6	123.2	8.6	131.8	2.0	0.0	25.4	27.4	0.0	0.0	159.8
	Total	261.3	2,941.9	46.0	2,987.9	62.9	34.2	441.9	539.0	0.0	+3.0	3,761.9
Nevada	Muddy	4.7	35.4	0.7	36.1	0.6	8.9	0.3	9.8	0.0	0.0	50.6
	Remaining area	0.0	65.5	1.0	66.5	1.7	3.5	150.3	155.5	0.0	-3.0	219.0
	Total	4.7	100.9	1.7	102.6	2.3	12.4	150.6	165.3	0.0	-3.0	269.6
New Mexico	Little Colorado	4.8	2.2	0.7	2.9	1.2	0.0	2.5	3.7	0.0	0.0	11.4
	Gila	0.4	4.2	2.2	6.4	6.6	0.0	0.3	6.9	1.0	0.0	14.7
	Total	5.2	6.4	2.9	9.3	7.8	0.0	2.8	10.6	1.0	0.0	26.1
Utah	Virgin	5.0	102.2	1.1	103.3	0.0	0.0	3.8	3.8	2.1	0.0	114.2
	Remaining area	0.2	9.7	0.2	9.9	0.0	0.0	0.1	0.1	0.0	0.0	10.2
	Total	5.2	111.9	1.3	113.2	0.0	0.0	3.9	3.9	2.1	0.0	124.4
Lower Basin	Little Colorado	18.4	90.2	5.9	96.1	3.6	22.5	12.3	38.4	0.0	11.4	164.3
	Virgin	5.3	122.1	1.4	123.5	0.0	0.0	4.3	4.3	2.1	0.0	135.2
	Muddy	4.7	35.4	0.7	36.1	0.6	8.9	0.3	9.8	0.0	0.0	50.6
	Bill Williams	25.8	24.2	1.1	25.3	1.7	0.0	1.8	3.5	0.0	0.0	54.6
	Gila	221.4	2,690.8	33.0	2,723.8	63.4	11.7	404.7	479.8	1.0	-37.7	3,388.3
	Remaining area	0.8	198.4	9.8	208.2	3.7	3.5	175.8	183.0	0.0	-3.0	389.0
	Total	276.4	3,161.1	51.9	3,213.0	73.0	46.6	599.2	718.8	3.1	529.3	4,182.0

¹ A portion of the consumptive uses shown herein are satisfied by ground-water overdraft.

² Includes rural, urban, and other industrial uses.

³ This value is included in the "Other" Municipal and Industrial Uses category, as listed in the annual report by the New Mexico Interstate Stream Commission as required by the Supreme Court decree in Arizona vs. California.

⁴ Excludes reservoir evaporation from Colorado River main stem reservoirs listed on table LC-1.

⁵ Central Arizona Project.

Table LC-9.—Lower Colorado River Basin
Irrigated acreage³
1981-1985

		(1,000 acres)				
State	Tributary	Irrigated acreage ¹				
		1981	1982	1983	1984	1985
Arizona	Gila ²	1,223.7	990.4	751.1	956.2	883.7
	Little Colorado	32.6	31.5	30.5	31.6	27.6
	Bill Williams	12.0	10.7	9.8	9.5	8.6
	Virgin	3.4	3.1	3.1	2.8	2.6
	Remaining area	<u>31.8</u>	<u>29.0</u>	<u>35.6</u>	<u>39.5</u>	<u>38.0</u>
	Total	1,303.5	1,064.7	830.1	1,039.6	960.5
Nevada	Muddy	10.8	10.9	11.2	10.7	10.5
	Remaining area	<u>8.2</u>	<u>9.3</u>	<u>8.3</u>	<u>8.3</u>	<u>9.2</u>
	Total	19.0	20.2	19.5	19.0	19.7
New Mexico	Gila	4.5	4.4	4.1	3.4	2.3
	Little Colorado	<u>2.5</u>	<u>2.1</u>	<u>1.2</u>	<u>1.4</u>	<u>1.6</u>
	Total	7.0	6.5	5.3	4.8	3.9
Utah	Virgin	21.3	21.7	21.6	22.4	22.4
	Remaining area	<u>3.3</u>	<u>3.4</u>	<u>3.4</u>	<u>3.2</u>	<u>3.2</u>
	Total	24.6	25.1	25.0	25.6	25.6
California	Remaining area	<u>116.5</u>	<u>116.4</u>	<u>103.4</u>	<u>113.9</u>	<u>110.5</u>
	Total	116.5	116.4	103.4	113.9	110.5
Lower Basin	Gila	1,228.2	994.8	755.2	959.6	886.0
	Little Colorado	35.1	33.6	31.7	33.0	29.2
	Bill Williams	12.0	10.7	9.8	9.5	8.6
	Virgin	24.7	24.8	24.7	25.2	25.0
	Muddy	10.8	10.9	11.2	10.7	10.5
	Remaining area	<u>159.8</u>	<u>158.1</u>	<u>150.7</u>	<u>164.9</u>	<u>160.9</u>
	Total	1,470.6	1,232.9	983.3	1,202.9	1,120.2

¹ Irrigated acreage includes all irrigated croplands harvested as well as irrigated pasture. Double-cropping is accounted.

² According to Arizona crop census reports, the fluctuation in irrigated acreage did occur.

³ Does not include main stem irrigated areas.

Table LC-10.--Lower Colorado River Basin
Population estimates
1981-1985

State	Tributary	Estimated population (1,000's)				
		1981	1982	1983	1984	1985
Arizona	Lower Main Stem*	166.4	153.3	160.7	167.1	170.9
	Gila	2,348.1	2,419.0	2,505.7	2,633.7	2,752.6
	Little Colorado	131.9	134.9	140.1	142.0	149.1
	Bill Williams	17.0	17.7	17.5	19.4	19.6
	Virgin	3.0	3.1	3.3	3.4	3.4
	Total	2,666.4	2,728.0	2,827.3	2,965.6	3,095.6
California	Lower Main Stem	23.8	21.9	22.9	23.8	24.3
Nevada	Lower Main Stem*	502.2	527.1	557.4	572.6	590.8
	Muddy	4.0	4.2	4.5	4.6	4.9
	Total	506.2	531.3	561.9	577.2	595.7
New Mexico	Gila	9.0	9.3	9.6	9.6	9.3
	Little Colorado	45.5	45.9	46.3	46.7	47.2
	Total	54.5	55.2	55.9	56.3	56.5
Utah	Lower Main Stem*	0.8	0.8	0.9	0.9	0.9
	Virgin	29.3	31.1	32.4	34.7	37.6
	Total	30.1	31.9	33.3	35.6	38.5
Lower Basin	Lower Main Stem	693.2	703.1	741.9	764.4	786.9
	Gila	2,357.1	2,428.3	2,515.3	2,643.3	2,761.9
	Little Colorado	177.4	180.8	186.4	188.7	196.3
	Bill Williams	17.0	17.7	17.5	19.4	19.6
	Virgin	32.3	34.2	35.7	38.1	41.0
	Muddy	4.0	4.2	4.5	4.6	4.9
	Total	3,281.0	3,368.3	3,501.3	3,658.5	3,810.6

* Includes remaining area population.

23-20

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47-2

IMPERIAL IRRIGATION DISTRICT
Imperial County, California

SUPPLEMENTAL DATA ON WATER OPERATIONS

Bookman-Edmonston Engineering, Inc.
Glendale, California

December 1983

Revised April 1987

**BOOKMAN-EDMONSTON
ENGINEERING, INC.**
100 North Brand Blvd.
GLENDALE, CA 91203

470.0

LETTER OF TRANSMITTAL

(818) 244-0117

DATE	1/19/88	JOB NO.	330
ATTENTION	JESSE SILVA		
RE:			

TO JESSE SILVA
IMPERIAL IRRIGATION DISTRICT
P.O. BOX 957
IMPERIAL CA 92251

WE ARE SENDING YOU Attached Under separate cover via _____ the following items:

- | | | | | |
|---|---------------------------------------|--------------------------------|----------------------------------|---|
| <input type="checkbox"/> Shop drawings | <input type="checkbox"/> Prints | <input type="checkbox"/> Plans | <input type="checkbox"/> Samples | <input type="checkbox"/> Specifications |
| <input type="checkbox"/> Copy of letter | <input type="checkbox"/> Change order | <input type="checkbox"/> _____ | | |

COPIES	DATE	NO.	DESCRIPTION
1	4/97		SUPPLEMENTAL DATA ON WINTER OPERATIONS

THESE ARE TRANSMITTED as checked below:

- | | | |
|--|---|---|
| <input type="checkbox"/> For approval | <input type="checkbox"/> Approved as submitted | <input type="checkbox"/> Resubmit _____ copies for approval |
| <input type="checkbox"/> For your use | <input type="checkbox"/> Approved as noted | <input type="checkbox"/> Submit _____ copies for distribution |
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| <input type="checkbox"/> For review and comment | <input type="checkbox"/> _____ | |
| <input type="checkbox"/> FOR BIDS DUE _____ 19 _____ | <input type="checkbox"/> PRINTS RETURNED AFTER LOAN TO US | |

REMARKS _____

 Attachment 38-41 were added
 in direct response to the State
 Bond Decision

COPY TO _____

SIGNED: _____

FOREWORD

The State Water Resources Control Board held hearings September 27, 28, and 29, 1983 on the alleged waste and unreasonable use of water by Imperial Irrigation District. Bookman-Edmonston Engineering, Inc. prepared five reports for those hearings.

Subsequent to September, Bookman-Edmonston has prepared additional data and analyses. This additional information is made available herein.

Included are tables and graphs which compile available information already in evidence in a more useable form. Also included is additional interpretative information based in part on information obtained during, and since, the September hearings.

Bookman-Edmonston Engineering, Inc.
Glendale, California
December 1983

FORWARD TO UPDATE OF APRIL 1987

The December 1983 Report was received in evidence by the State Board as Exhibit IID, 16. This edition has been updated and revised through 1986. Most changes in the Attachments are the addition of data for years 1983 through 1986 in which case the Attachments are noted as being "updated". In some cases hydrologic work by this firm since 1983 has resulted in revisions of the calculations. Where revisions to data prior to 1983 have been made the Attachments are noted as being "revised".

Additional data developed after 1983 which may be helpful is included. This additional data begins with Attachment 37.

Bookman-Edmonston Engineering, Inc.
Glendale, California
April 1987

The data following is organized as general information, flow data, crop data, water balance of Imperial Valley, Salton Sea, water use efficiency and items relating to reasonable use of water. Additional data is included beginning with Attachment 37.

GENERAL

Attachment 1 is a map of the Salton Sea drainage area and the irrigated area within the Imperial ID.

Attachment 2 shows the Salton Sea and the areas flooded since 1920.

FLOW DATA

Attachment 3 shows for Imperial ID the diversions from the Colorado River, water received at Drop No. 1 and water delivered to users since 1960.

Attachment 4 is an update through 1986 of Table 4 of the DWR December 1981 report. Metric units are not shown.

Attachments 5 and 6 are operation graphs prepared by IID which show daily variations in water use for 1976 and 1982 based on deliveries at Drop No. 1. The daily rainfall is noted thereon. These graphs illustrate the seasonal variations and also the rapid fluctuation in water demands caused by weather changes.

CROP AND CONSUMPTIVE USE DATA

Attachment 7 shows the areas of crops in IID from 1960 through 1986. This illustrates a change in cropping pattern.

Attachment 8 is a graph showing the change in the total area irrigated in IID.

Attachment 9 is a schedule of planting and harvesting dates illustrating the diversity of cropping activity in IID.

Attachment 10 is an estimate of the consumptive use of water by crops in IID for the period 1977-1979. This data is based on IID calculations, except for alfalfa which is based on DWR information as to area and unit consumptive use.

Attachment 11 is an estimate of annual consumptive use for the period 1960 through 1986. This illustrates a moderate increase in consumptive use in the last 20 years, which increase is less than the increase in irrigated area.

WATER BALANCE

Attachment 12 is a schematic drawing of the water operation of IID.

In the 1983 report Attachments 13 and 14 were water balance and water operations for Imperial Valley for 1977-79 and 1982 respectfully. Additional hydrology has been done by Bookman-Edmonston since that time and water balance and operations for years beginning with 1975 have been prepared. These are shown in revised Attachments 13A (water balance) and 14A (water operations).

Attachment 14B is an annual estimate of nonconsumptive distribution and irrigation losses. These were derived from the water balance and operations Tables. These three Tables show a clear decline in system losses over the period of analysis. In Attachment 14B total losses declined from a three year average of 971,000 acre-feet in 1975-77, to 751,000 acre-feet for 1984-86, a change of 220,000 acre-feet.

The 1977-79 water balance shows inflow to the Salton Sea from Imperial Valley was derived from the following sources:

Canal seepage	195,000 AF
Carriage water and operational spill	135,000 AF
Leach water	280,000 AF
Tailwater	312,000 AF
Sewage, industrial, service pipe and return flow from land reclamation	26,000 AF
Mexico, Coachella Canal, Westside ground water and precipitation	<u>195,000 AF</u>
Total - Imperial Valley	1,143,000 AF

The total inflow to Salton Sea from agriculture and municipal operations in IID totaled 948,000 acre-feet for 1977-79. The value for 1986 was reduced to 750,000 acre-feet.

SALTON SEA

Attachment 15 shows the historical elevation of the Salton Sea through December 1986.

Attachment 16 shows the elevation since 1961 at a larger scale.

Attachment 17 shows the relationship between Salton Sea elevation and average annual evaporation.

Attachment 18 is the historical change in Salton Sea's salinity and elevation as compiled from data and measurements made by IID. It can be seen from Attachment 18 that a rising elevation causes a decrease in sea salinity.

Attachment 19 is the Historic Salton Sea Water Budget. This budget has been revised using the IID data for elevation of Salton Sea and a formula for area capacity relationships. The changes in calculated inflow from the 1983 Table are minor.

Attachment 20 shows the components of inflow to the Salton Sea. "Other" includes subsurface inflow, storm flow from outside of irrigated areas and any error. Revisions to this Attachment are based on more detailed hydrologic analysis.

Attachment 21 shows the basis for determining the component of inflow from Imperial and Coachella.

Attachment 22 is a graphic representation of Attachment 20.

Attachment 23 represents several historical operational studies under different assumptions as to inflow to Salton Sea.

Attachment 24 shows the effect on elevation of an assumed one-foot increase in sea elevation. Following 27 years, the effect of a one-foot rise has been reduced to 0.15 feet.

POWER GENERATION

Attachment 25 shows the electrical energy production at the IID All-American Canal hydro plants. All water delivered through these plants, including that which subsequently flows to the Salton Sea, is beneficially used for power production.

EFFICIENCY

Attachment 26 defines irrigation efficiency.

Attachment 27 shows the irrigation efficiency of IID based on the water balance in Attachments 13 and 14. Attachment 28 shows the same data on a per acre basis.

Attachment 29 shows the relationship of inflow to the Salton Sea from IID to diverted water, delivered water and irrigated area. This data indicates that the operation at IID has not been erratic. Attachment 29 has been supplemented to more clearly indicate a changing pattern of use.

REASONABLENESS OF OPERATIONS

The following attachments are items considered by Bookman-Edmonston in evaluating reasonableness of water use by IID:

Attachment 30 states that the reasonableness of water use depends upon the particular circumstances.

Attachment 31 discusses the reasonable use of water by IID.

Attachment 32 lists items to consider in evaluating reasonableness of water use.

Attachment 33 lists actions taken by IID to improve water delivery use and disposal efficiency.

Attachment 34 lists conditions in IID that restrict irrigation efficiency.

Attachment 35 lists factors which must be considered in determining reasonability of water use.

Attachment 36 is a series of questions regarding reasonable use of water by Imperial Irrigation District.

These questions were asked James Welsh of Bookman-Edmonston Engineering, Inc. on November 30, 1983 in the Superior Court of Imperial County. Mr. Welsh answered "yes" to questions 1 through 5 and "no" to question 6.

ADDITIONAL DATA

Several Attachments have been added to the April 1986 revision. These represent information which has been developed since 1983 and may be helpful.

Attachment 37 shows that even without changes in IID that the Metropolitan Water District had surplus water and use of less water by IID would not have changed Metropolitan's operations.

Attachment 38 shows that water conserved by IID would only have added to Colorado River flood releases.

Attachment 39 illustrates the effect of storms on the rising level of Salton Sea.

Attachment 40 summarizes the California diversions from the Colorado River.

Attachment 41 discusses the Salton Sea elevation in February 1984.

SUMMARY

Attachments 31 through 36 list factors which need to be evaluated concerning the reasonableness of use of water by Imperial Irrigation District. These factors have been considered by Bookman-Edmonston Engineering, Inc. and we conclude that Imperial Irrigation District has operated in a reasonable and efficient manner. The practices in Imperial Irrigation District are reasonable and are more efficient than those of many similar areas.

The Imperial Irrigation District has actively pursued economical means to increase water use effectiveness, reduce the diversion of water from the Colorado River, including canal lining, waste checking, careful scheduling, reservoir

construction, and cooperation with the USBR and others as enumerated in our report for the September SWRCB hearings. There is additional water which could be conserved within IID. This additional conservation is not economic for IID and at this time is not needed by IID or any of the succession of parties who have a right or need for conserved water. The reduction of diverted water would only result in a greater inflow to the Pacific Ocean. The water that IID is alleged to be wasting is, in fact, performing a beneficial use in generating power, acting as a carriage water and reducing the salinity of the Salton Sea.

We therefore conclude that the irrigation and drainage operations of Imperial Irrigation District are reasonable, careful and lawful.



LOCATION MAP

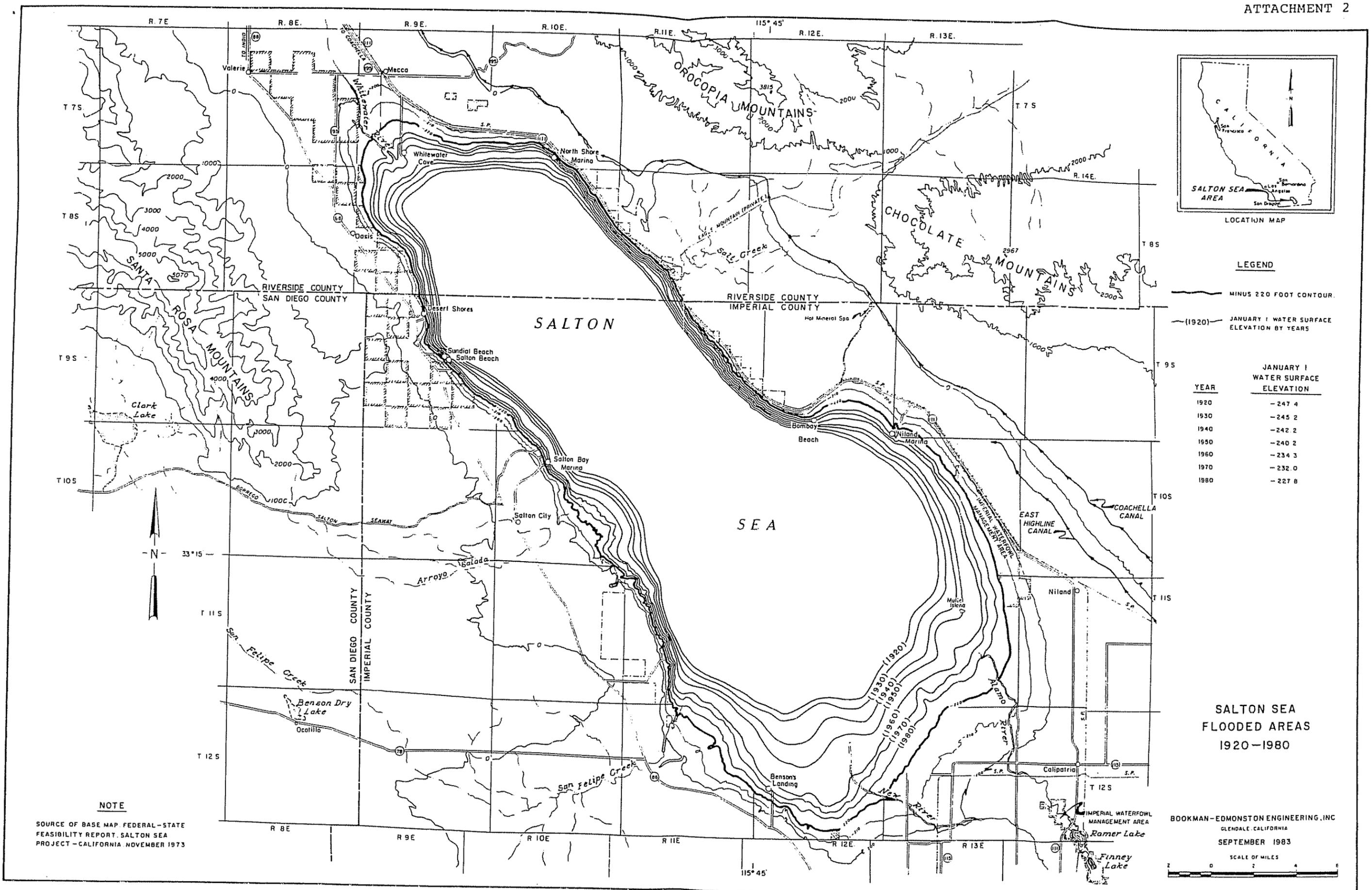
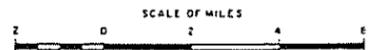
LEGEND

- MINUS 220 FOOT CONTOUR.
- (1920) JANUARY 1 WATER SURFACE ELEVATION BY YEARS

YEAR	JANUARY 1 WATER SURFACE ELEVATION
1920	-247.4
1930	-245.2
1940	-242.2
1950	-240.2
1960	-234.3
1970	-232.0
1980	-227.8

SALTON SEA FLOODED AREAS 1920-1980

BOOKMAN-EDMONSTON ENGINEERING, INC.
 GLENDALE, CALIFORNIA
 SEPTEMBER 1983



NOTE

SOURCE OF BASE MAP FEDERAL-STATE FEASIBILITY REPORT, SALTON SEA PROJECT - CALIFORNIA NOVEMBER 1973

WATER DELIVERIES TO
IMPERIAL IRRIGATION DISTRICT

(in thousands of acre-feet)

Year	Total Diversion from Colorado River less Return to the River (1)	Water Received at Drop No. 1 (2)	Total Deliveries to Users (3)
1961	3,036	2,957	2,196
62	3,006	2,951	2,224
63	3,062	2,991	2,285
64	2,808	2,770	2,399
1965	2,688	2,624	2,312
1966	2,886	2,818	2,470
67	2,770	2,720	2,365
68	2,864	2,806	2,476
69	2,714	2,676	2,352
1970	2,808	2,755	2,418
1971	2,939	2,884	2,535
72	2,903	2,847	2,531
73	3,009	2,956	2,670
74	3,133	3,072	2,777
1975	3,047	3,001	2,704
1976	2,831	2,784	2,515
77	2,717	2,693	2,455
78	2,715	2,672	2,441
79	2,844	2,803	2,571
1980	2,817	2,769	2,520
1981	2,839	2,769	2,500
82	2,565	2,516	2,248
83	2,509	2,416	2,180
84	2,687	2,647	2,386
1985	2,678	2,617	2,335
1986	2,693	2,576	2,337

- (1) From California Colorado River Board Statement prepared for SWRCB hearings of September 1983; recent data from IID Annual Reports.
- (2) From IID Annual Reports.
- (3) From IID. Does not include deliveries through service pipes.
- (4) Data beginning in 1983 from Colorado River Board and IID.

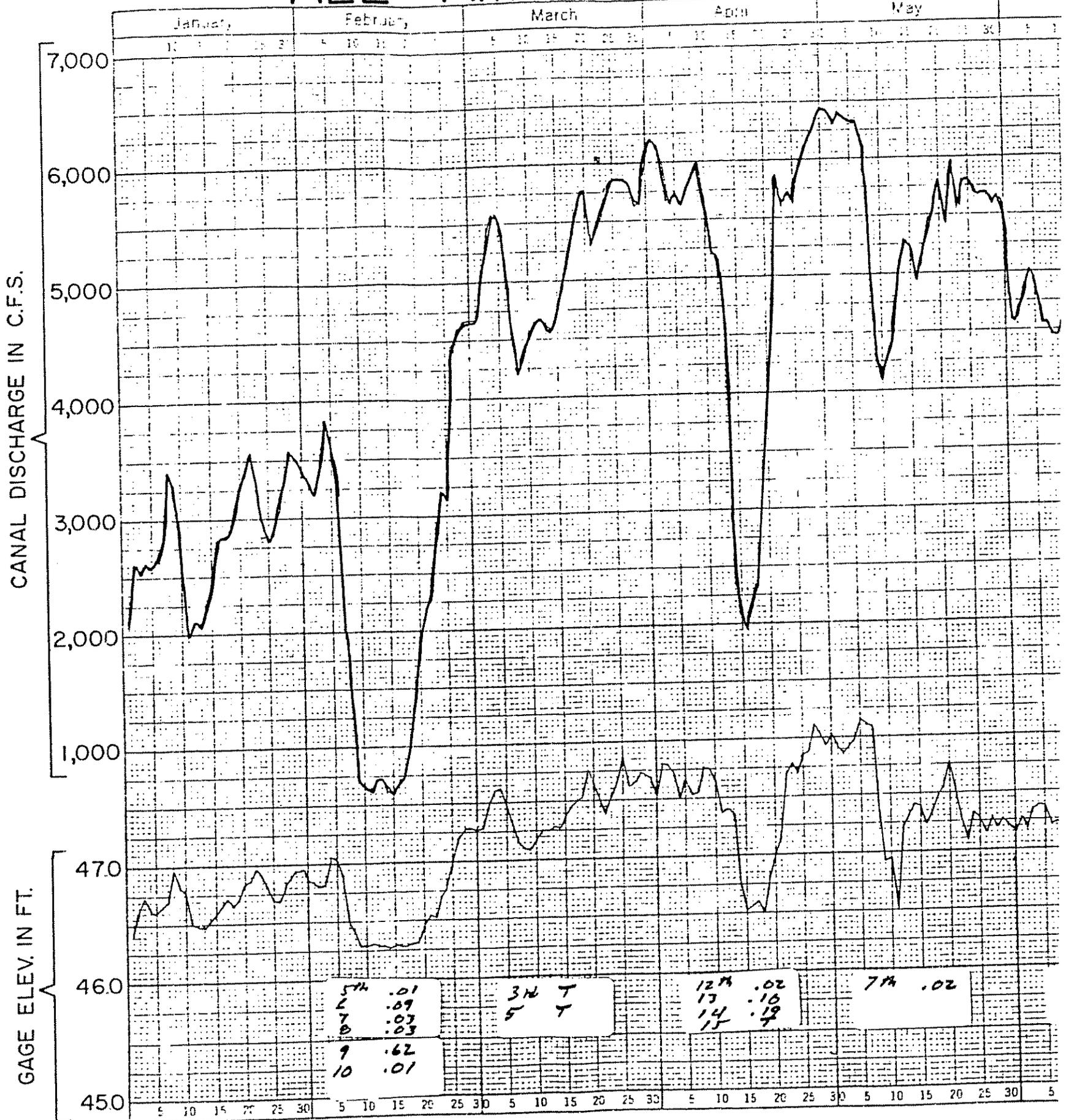
IMPERIAL IRRIGATION DISTRICT
CONVEYANCE SYSTEM EFFICIENCIES, 1955-86 (a)(b)

(In Thousands of Acre-Feet)

Year	: Water Received : : by District at : Drop l	: Deliveries : : to Users(c):	: Operational : : Losses(d)	: Conveyance : : System : Efficiency(%)
1955	2,927	1,961	966	67.0
1956	2,907	2,012	895	69.2
1957	2,782	1,949	833	70.1
1958	2,731	1,941	790	71.1
1959	2,840	2,045	795	72.0
1960	2,984	2,178	806	73.0
1961	2,957	2,196	761	74.2
1962	2,951	2,224	727	75.4
1963	2,991	2,285	706	76.4
1964(e)	2,770	2,399	371	86.6
1965	2,624	2,312	312	88.1
1966	2,818	2,470	348	87.7
1967	2,720	2,365	355	87.0
1968	2,806	2,476	330	88.2
1969	2,676	2,352	324	87.9
1970	2,755	2,418	337	87.8
1971	2,884	2,535	349	87.9
1972	2,847	2,531	316	88.9
1973	2,956	2,670	286	90.3
1974	3,072	2,777	295	90.4
1975	3,001	2,704	297	90.1
1976	2,784	2,515	269	90.3
1977	2,693	2,455	238	91.2
1978	2,672	2,441	231	91.3
1979	2,803	2,571	232	91.7
1980	2,769	2,520	249	91.0
1981	2,769	2,500	269	90.3
1982	2,516	2,248	268	89.3
1983	2,416	2,180	236	90.2
1984	2,647	2,386	261	90.1
1985	2,617	2,335	282	89.2
1986	2,576	2,337	239	90.7

- (a) Taken from DWR Report, December 1981, Investigation Under California Water Code Section 275 of Use of Water by Imperial Irrigation District. Data is from Table 4 thereof through 1979 and supplemented by Bookman-Edmonston thereafter.
- (b) Source: Imperial Irrigation District, Annual Summary, Water Diversion, Transportation, Distribution and Drainage, United States and Mexico, 1955-82.
- (c) This is water released to canals adjacent to farmers' headgates for subsequent delivery through the headgates. Portions of this water which are rejected by farmers and not diverted to others as a supplemental delivery may spill at the end of the canal. This type of loss (included here as part of "Deliveries") has been approximated at 1 to 2 percent of the "delivery" amount (J. R. Wilson telephone interview March 26, 1981).
- (d) Operational losses include evaporation, seepage, leakage, and approximately 1600 minor service pipes which are unmeasured.
- (e) In 1964, the District changed calibration on the flow measurements to water users by 10 percent.

ALL AMERICAN CANAL BEL



5th .01
 6 .09
 7 .07
 8 .03
 9 .62
 10 .01

3rd T
 5 T

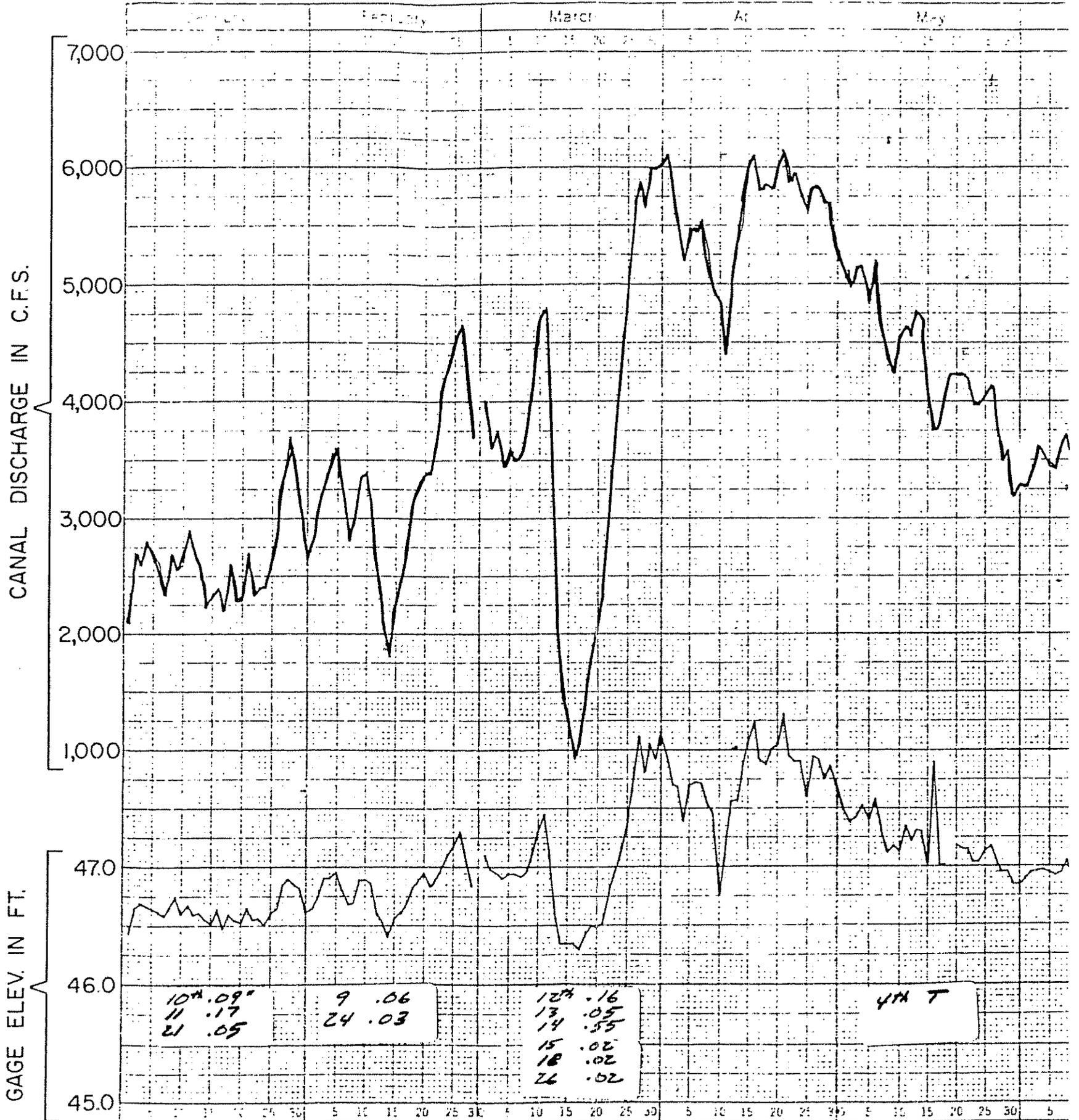
12th .02
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 14 .19
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7th .02

OW DROP N^o 1 - 1976



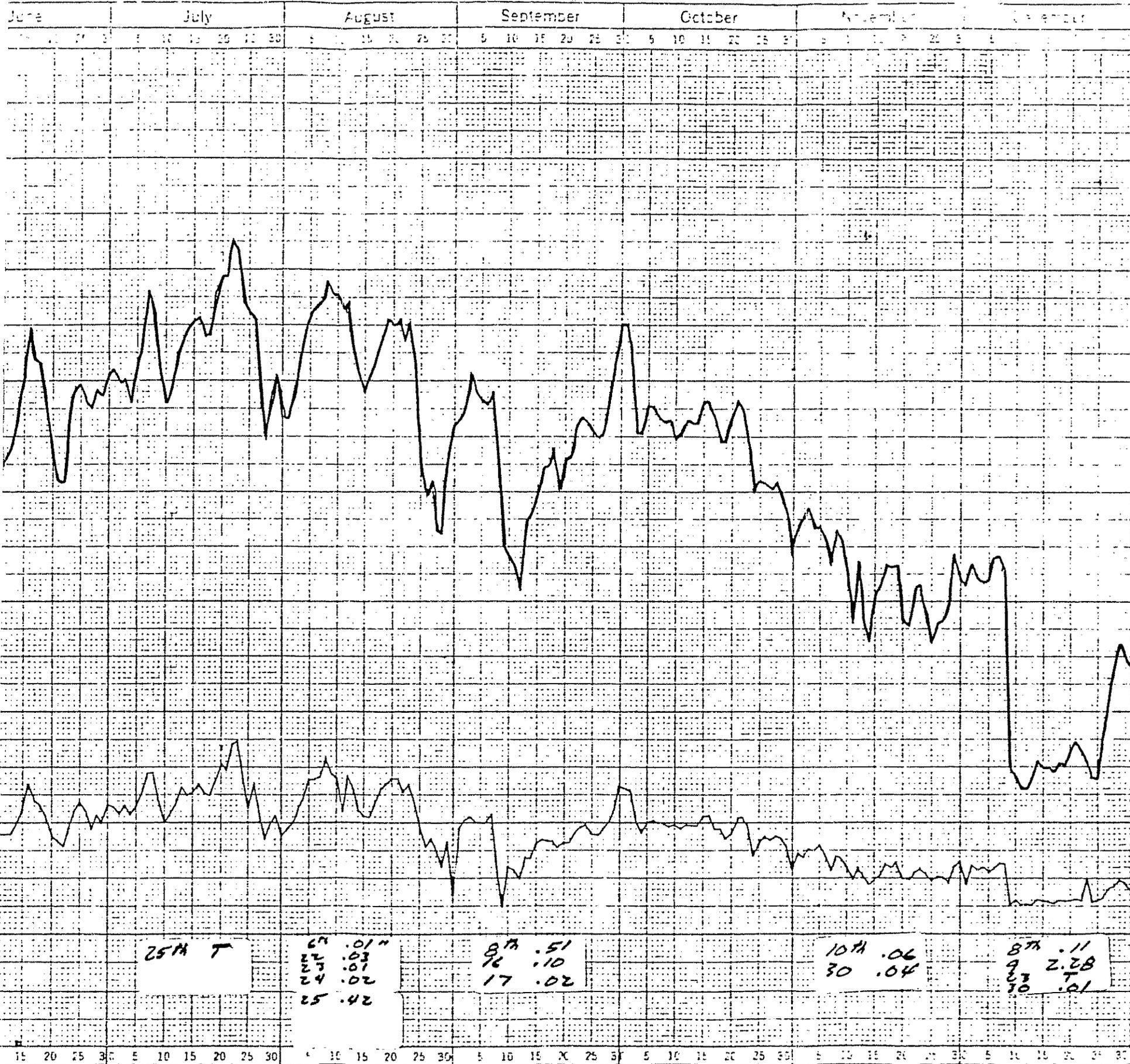
ALL AMERICAN CANAL BELMONT



RAINFALL

W DROP N°1 - 1982

ATTACHMENT 6



IMPERIAL IRRIGATION DISTRICT

CROPPING PATTERN (a)
1960 - 1986

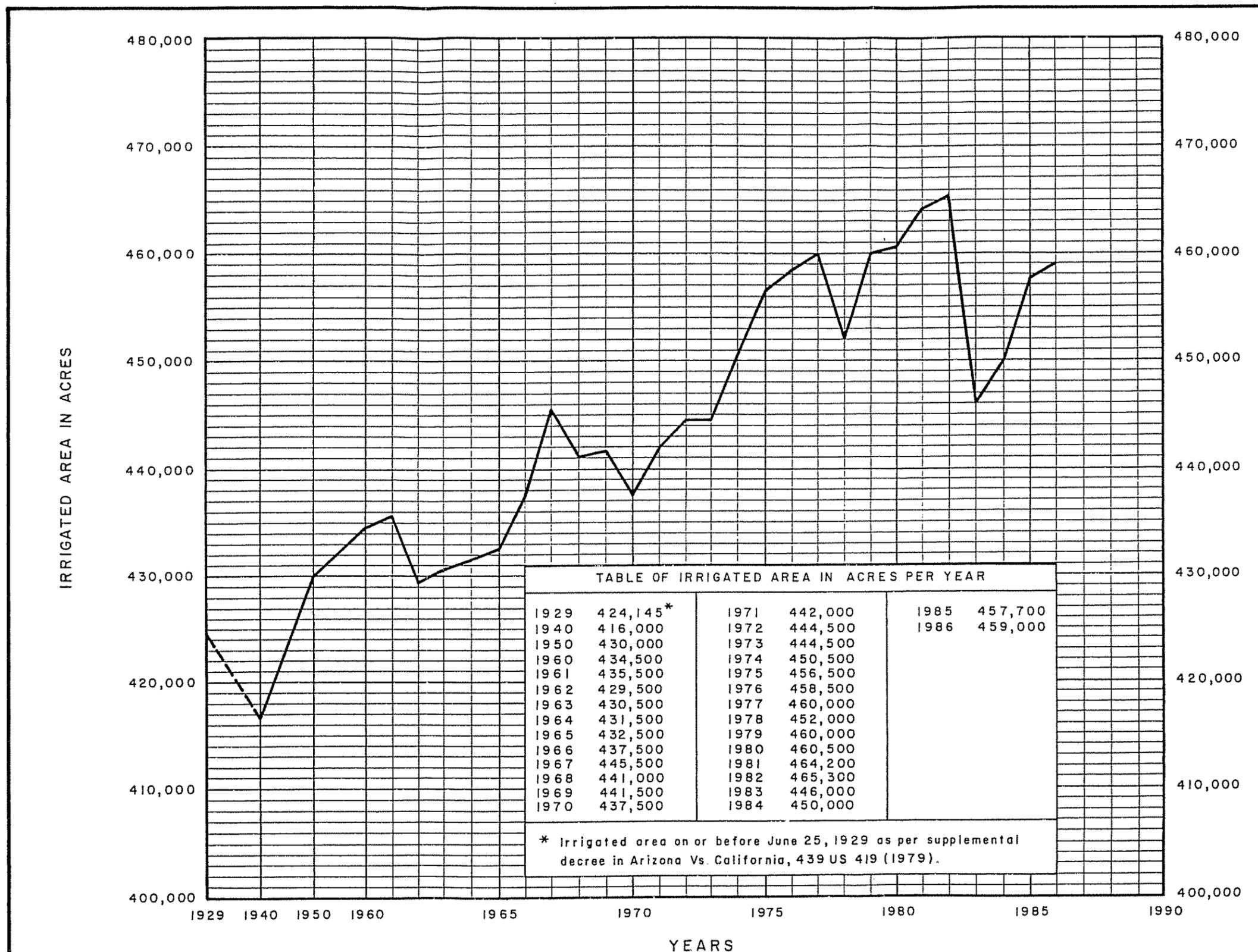
(Values in Thousands of Acres)

	1960	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Alfalfa(b)	174.5	141	144.7	141.9	139.5	125.3	126.5	134.4	141	143	151.8	150.5	138.3	161.	165	175.5	169.6	169.8
Barley	82	57.5	62	48.5	17.5	5.5	3.5	3.5	7	7.5	4	2	5	0	0	0	.3	.4
Cotton	58	34.5	32.5	30.5	37	79	43	67	138	61.5	83	83.5	80	42	18	27.5	20.7	19.0
Sorghum, Grain	0	57.5	49.5	50.5	39.5	31.5	24.5	17	7	15	8.5	4	2.5	2.5	1.5	1.5	.6	.5
Sudan	5.5	8	8	9.5	13	14.5	13	26	6.5	12	24.5	20.5	22	8	10.5	24.5	15.3	10.5
Sugar Beets	48.5	63.5	65.5	67	70	69	71.5	74	60	36.5	48	37	44	37.5	39.5	38	37.3	34.0
Wheat	1	62.5	40	51	94.5	101.5	155.5	146.5	67.5	135.5	100	142	164.5	175	99.5	97	77	92.8
Misc. Field Crops	55	27.5	32	37	26	16.5	16	13.5	12	20	14.5	8.5	13	19.5	24	25	30.9	26.8
Melons	11.5	11	12	16	13	11	11.5	12.5	15	17	15.5	17	21.5	24	22	24.5	31.2	25.4
Lettuce	40.5	48	37	40	41	48.5	45	44.5	39.5	41.5	43.5	44.5	37	31	26.5	27	28.1	13.9
Carrots	3.5	4.5	4	5	5	6.5	6	7.5	4.5	6.5	9	7.5	7	9	7.5	10	13.4	8.8
Tomatoes	2	3	2	2	2.5	3	6	3.5	4.5	3.5	3	1.5	3.5	3	3	4.5	4.4	3.0
Misc. Garden Crops	7.5	8.5	9	8.5	9.5	12.5	15	11.5	11	16.5	18	16.5	16	21.5	19	22	21.2	19.1
Citrus	2	2.5	3	2.5	2.5	2.5	2.5	2	2	2	1.5	1.5	1.5	1.5	2	2	2.1	1.4
Misc. Permanent Crops	3	11.5	11.5	13	14	13.5	13	14	12.5	11.5	12	12.5	13	17	21	17	18.9	17.7
TOTAL(c)	494.5	541	512.7	522.9	524.5	540.3	552	577.4	528	529.5	536.8	549	564.3	552.5	460.1	498.3	466.9	450.7
Net Acres Irrigated	434.5	437.5	442	444.5	444.5	450	456.5	458.5	460	452	460	460.5	464.5	465.5	446	450	457.7	459.0

(a) Source: Imperial Irrigation District (rounded to nearest 500 acres).

(b) Amount shown is acreage reported by IID multiplied by .793 which adjusts for overlap of years. Ratio based on DMR comparison for 1977-79.

(c) Includes double crops.



SOURCE: IMPERIAL IRRIGATION DISTRICT RECORDS.

IMPERIAL IRRIGATION DISTRICT IRRIGATED AREA 1929-1986

SCHEDULE OF MAJOR CROPS - PLANTING AND HARVEST - IMPERIAL VALLEY

VEGETABLE CROPS	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
MAJOR CROPS												
Asparagus							seed, crowns					
Broccoli												
Cantaloupes						cap	open					
Carrots												
Garlic												
Lettuce												
Onions												
- Dehydrator												
- Fresh market												
- Seed												
Tomatoes												
- Open, cannery												
- Brushed, staked												
Watermelons						cap	open					
MINOR CROPS												
Cabbage												
Cucumbers												
Melons												
- Casaba												
- Honeydew						cap	open					
- Persian												
Rapini												
Okra												
Onions												
- Bunching												
Romaine												
Sweet Corn												
Squash												
- Summer												
- Banana												

Preparation & planting  Cultivation, growth & lay-by  Harvest 

Seed crops follow seasonal cropping.

Cattle feeding is a major operation throughout the year.

Lamb feeding - December through March.

FIELD CROPS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alfalfa for Hay (3 to 4 yr. crop)												
Alfalfa Seed												
							seed production					
Cereals (wheat)												
Cotton												
Flax												
Sesbania												
Sorghums (forage)												
Sorghum (grains)												
Sugar Beets												

Preparation & planting  Cultivation, growth & lay-by  Harvest 

Alfalfa seed is usually produced in the last year of hay production. Hay is harvested until about May 15; then seed is produced during June, July and August. Seed is harvested from about August 15 through September 15.

Grain sorghums may be planted from February 15 to August 10. The crop may be harvested from July 1 to December 15. Decisions on when to plant and the variety to be grown depend on management practices and other crop schedules.

These charts graphically illustrate the calendar of events for major crops grown in Imperial County. The periods of planting and harvesting represent the general trend and do not illustrate the variations in practices which may be utilized.

IMPERIAL IRRIGATION DISTRICT

CROPPING PATTERN AND
CONSUMPTIVE USE (a)
1977-79

Crop Category	: Area : ac.	: Estimated Consumptive Use : AF/ac.	: AF
Alfalfa	145,250 ^(b)	5.4 ^(b)	784,350
Barley	6,198	1.8	11,156
Cotton	94,208	3.6	339,149
Sorghum, Grain	10,240	2.5	25,600
Sudan	14,280	2.5	35,700
Sugar Beets	48,017	3.7	177,663
Wheat	100,974	2.1	212,045
Miscellaneous Field Crops	15,582	2.5	38,955
Melons	15,797	2.3	36,333
Lettuce	41,521	1.4	58,129
Carrots	6,694	1.3	8,702
Tomatoes	3,625	2.3	8,338
Miscellaneous Garden Crops	15,062	1.7	25,605
Citrus	1,798	3.8	6,832
Miscellaneous Permanent Crops	12,173	4.2	51,127
Total ^(c)	531,419	3.4	1,819,684
Net Cropped Area	457,048	4.0	1,819,684

(a) Source: Imperial Irrigation District

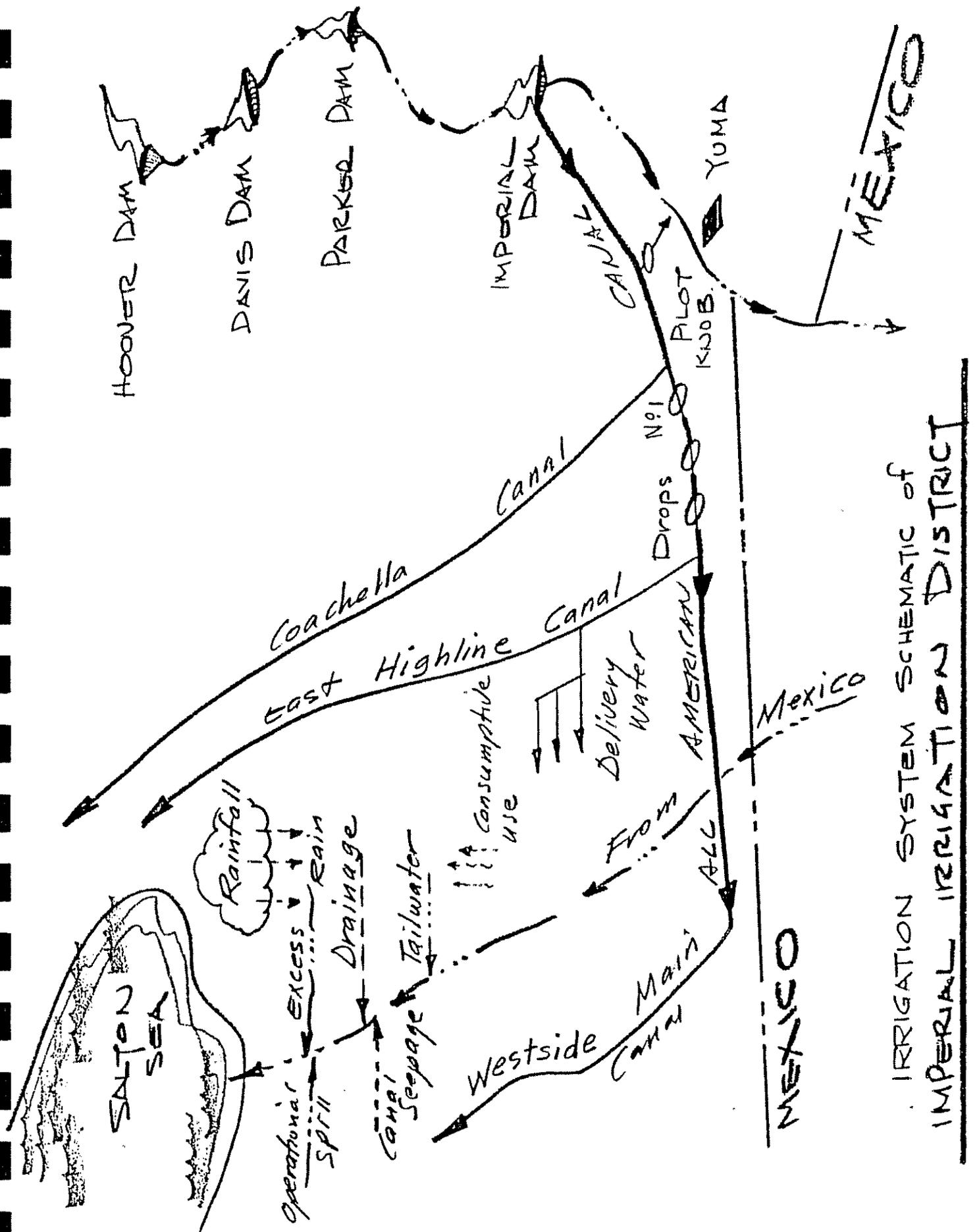
(b) Source: California Department of Water Resources

(c) Includes multiple-cropped areas

IMPERIAL IRRIGATION DISTRICT
IRRIGATED AREA AND CONSUMPTIVE USE OF CROPS
1960-1986

Year	Net Irrigated Area in Acres (1)	Average Consumptive Use AF/Acre (2)	Consumptive Use in Acre-feet (3)
1960	434,500	4.04	1,756,800
1970	437,500	4.04	1,766,400
71	442,000	3.90	1,724,900
72	444,500	3.92	1,744,300
73	444,500	3.95	1,756,300
74	450,000	3.98	1,793,100
1975	456,500	3.88	1,770,600
76	458,500	4.13	1,891,800
77	460,000	4.09	1,883,400
78	452,000	3.88	1,751,700
79	460,000	3.99	1,833,200
1980	460,500	3.98	1,834,200
81	464,500	3.97	1,843,800
82	465,500	3.94	1,832,900
83	446,000	3.66	1,633,500
84	450,000	3.90	1,754,600
1985	457,700	3.65	1,669,400
1986	459,000	3.57	1,637,700

- (1) From IID Data.
(2) Average Value based on Columns (1) and (3).
(3) Calculated total consumptive use of crops based on calculations by IID using Kaddah and Rhoades except for alfalfa. Alfalfa acreage was adjusted by ratio of DWR 1977-79 alfalfa acreage to IID reported acreage (.793). Alfalfa unit consumptive use value was based on DWR (5.4 AF/A).



IRRIGATION SYSTEM SCHEMATIC of
IMPERIAL IRRIGATION DISTRICT

WATER BALANCE
OF IMPERIAL VALLEY
1975-1986

(Values in Thousands of Acre-Feet)

Water Requirement	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
<u>Supply</u>												
Colorado River inflow at Drop No. 4	2,934	2,741	2,664	2,638	2,787	2,731	2,731	2,492	2,385	2,611	2,576	2,532
Surface inflow from Mexico	101	104	109	100	146	158	158	159	245	270	262	267
Subsurface inflow												
Coachella Canal	54	54	54	54	54	54	54	54	54	54	54	54
Westside	15	15	15	15	15	15	15	15	15	15	15	15
Mexico	7	7	7	7	7	7	7	7	7	7	7	7
Precipitation	70	268	258	217	116	215	125	250	287	169	190	194
TOTAL	3,181	3,189	3,107	3,031	3,125	3,180	3,090	2,977	2,993	3,126	3,104	3,069
<u>Use</u>												
Crop consumptive use (a)	1,805	1,827	1,807	1,758	1,763	1,811	1,812	1,760	1,705	1,807	1,847	1,807
Consumptive use (minor items)	34	36	36	38	40	38	37	36	35	36	35	36
Water Surface Evaporation	30	30	30	30	30	30	30	31	31	31	31	31
Consumptive Use of native vegetation	13	38	35	41	20	30	21	34	41	18	29	26
Consumptive use of phreatophytes	67	67	67	67	67	67	67	67	67	67	67	67
TOTAL	1,949	1,998	1,975	1,934	1,920	1,976	1,967	1,928	1,879	1,959	2,009	1,967
Difference supply and use	1,232	1,191	1,132	1,097	1,205	1,204	1,123	1,049	1,114	1,167	1,095	1,102
<u>Inflow to Salton Sea</u>												
Alamo River	682	639	615	603	635	642	592	543	552	564	510	499
New River	435	435	413	393	458	455	433	416	477	512	489	512
Drains flowing directly to sea	113	115	102	99	110	105	96	88	83	89	94	89
Subsurface outflow	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL	1,232	1,191	1,132	1,097	1,205	1,204	1,123	1,049	1,114	1,167	1,095	1,102

(a) Closure term in hydrologic balance.

IMPERIAL IRRIGATION DISTRICT
WATER OPERATIONS
1975-1986

(Values in Thousands of Acre-Feet)

Type of Use	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Water Available for Delivery	2,934	2,741	2,664	2,638	2,787	2,731	2,731	2,492	2,385	2,611	2,576	2,532
Inflow at Drop No. 4	25	25	25	25	25	25	25	25	25	25	25	25
Plus seepage recovery	233	228	223	220	218	215	211	209	206	200	196	195
Less canal seepage	137	137	135	135	135	135	112	90	88	88	88	88
Less carriage water and operational discharge	18	18	18	18	18	18	18	19	19	19	19	19
Less canal and reservoir evaporation	2,571	2,383	2,313	2,290	2,441	2,388	2,415	2,199	2,097	2,329	2,298	2,255
Equals water delivered to users												
Water flow to drains	345	340	333	330	328	325	298	274	269	263	259	258
Water Delivered (applied water)	2,513	2,323	2,254	2,226	2,375	2,324	2,352	2,138	2,037	2,267	2,236	2,193
Crops	58	60	59	64	66	64	63	61	60	62	62	62
Other users												
Consumptive Use of Applied Water	1,778	1,720	1,696	1,668	1,713	1,719	1,758	1,655	1,586	1,729	1,767	1,727
Crops	34	36	36	38	40	38	37	36	35	36	35	36
Other uses												
Applied Water Flowing to Drains	735	603	558	558	662	605	594	493	451	538	469	466
From crops (leaching and tailwater)	24	24	23	26	26	26	26	25	25	26	27	26
Other uses												
Total IID Inflow to Drains	1,104	967	914	914	1,016	956	918	782	745	827	755	750
Other Inflow to Drains and Losses	101	104	109	100	146	158	158	159	245	270	262	267
Surface inflow from Mexico	76	76	76	76	76	76	76	76	76	76	76	76
Plus subsurface inflow	70	268	258	217	116	215	125	250	287	169	190	194
Plus precipitation	12	12	12	12	12	12	12	12	12	12	12	12
Less losses (evaporation from drains, rivers, and ponds)	80	105	102	108	87	97	88	101	108	85	96	93
Less consumptive use of phreatophytes and native vegetation	27	107	111	90	50	92	54	105	119	78	80	80
Less crop consumptive use of precipitation	2	2	2	2	2	2	2	2	2	2	2	2
Less subsurface outflow	126	222	216	181	187	246	203	265	367	338	338	350
Equals other inflow												
Total Surface Outflow from IID	1,230	1,189	1,130	1,095	1,203	1,202	1,121	1,047	1,112	1,165	1,093	1,100

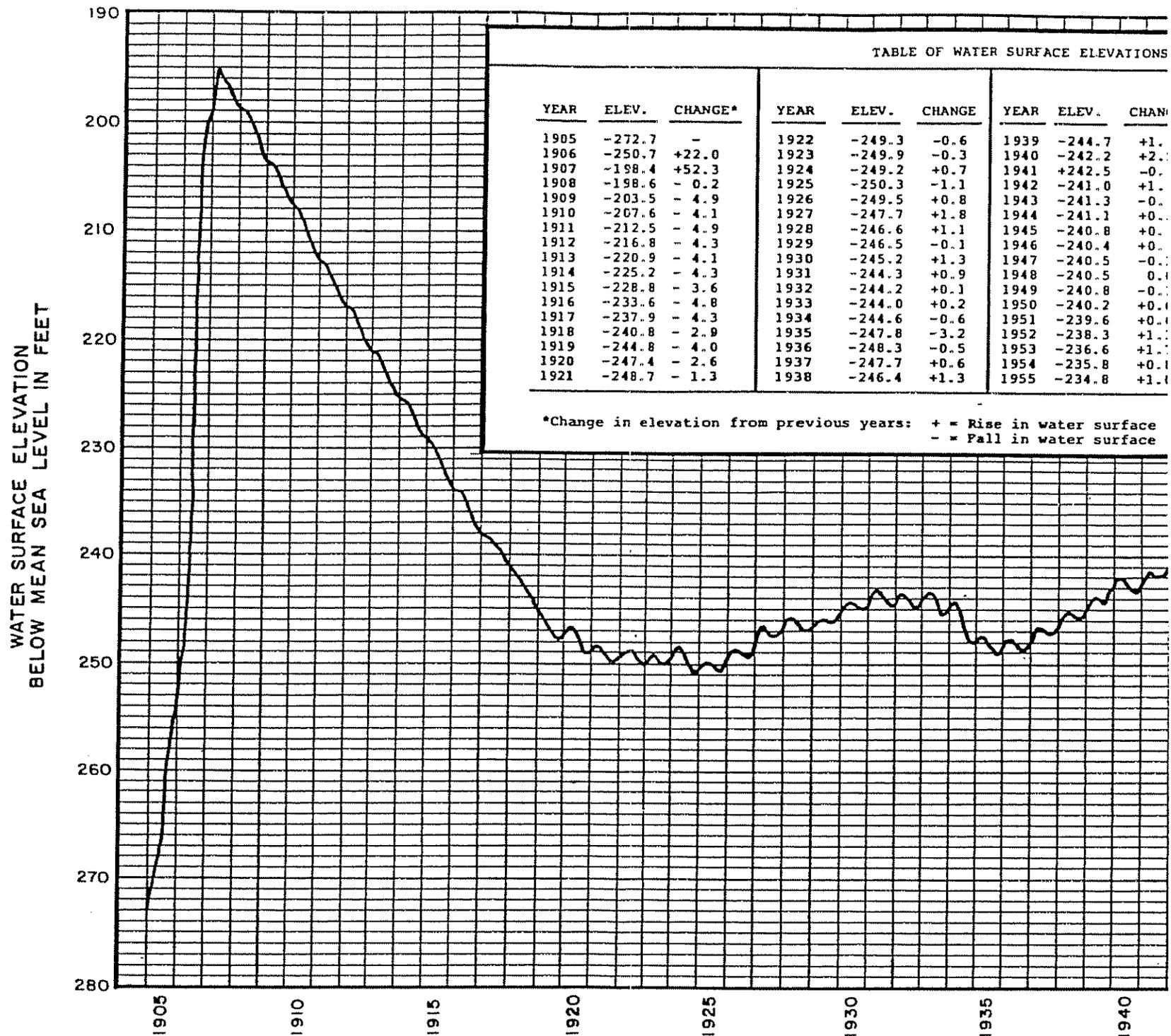
ESTIMATED ANNUAL AMOUNTS OF NONCONSUMPTIVE
DISTRIBUTION SYSTEM AND IRRIGATION LOSSES
IN IMPERIAL IRRIGATION DISTRICT SYSTEM

(Values in Thousands of Acre-Feet)

Year	Canal Seepage Below Drop No. 4(a)	Operational Discharge	Tailwater(b)	Leach- water(b)	Total
1975	208	137	455	280	1,080
76	203	137	323	280	943
77	198	135	278	280	891
78	195	135	278	280	888
1979	193	135	382	280	990
1980	190	135	325	280	930
81	186	112	314	280	892
82	184	90	203	280	757
83	181	88	171	280	720
1984	175	88	258	280	801
1985	171	88	189	280	728
1986	170	88	186	280	724
<u>Average</u>					
12-year	188	114	280	280	862
1975-77	203	136	352	280	971
1984-86	172	88	211	280	751

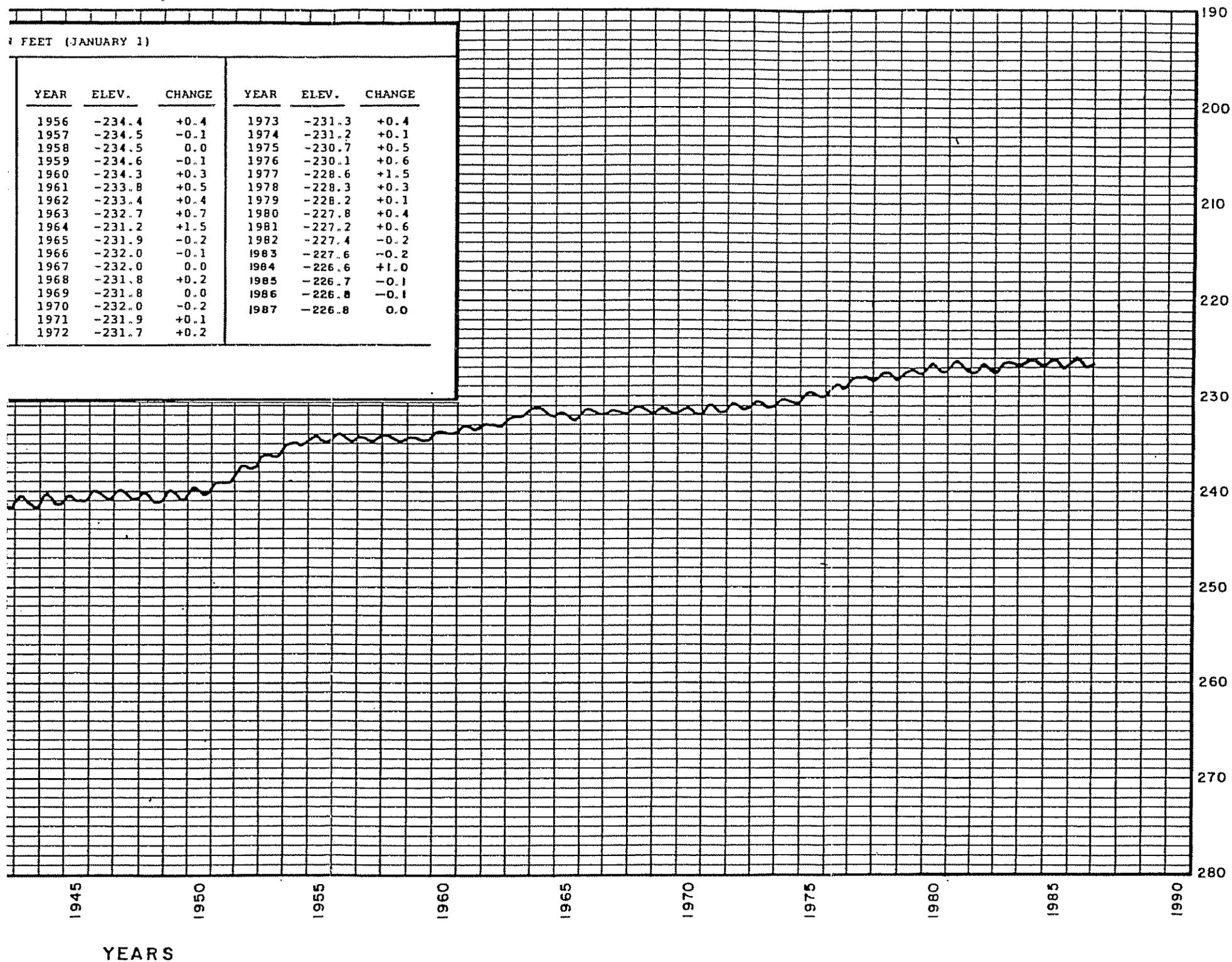
(a) Canal seepage adjusted for seepage return

(b) From Table of IID Water Operations; calculated leachwater is 280,000 AF and tailwater is residual amount.



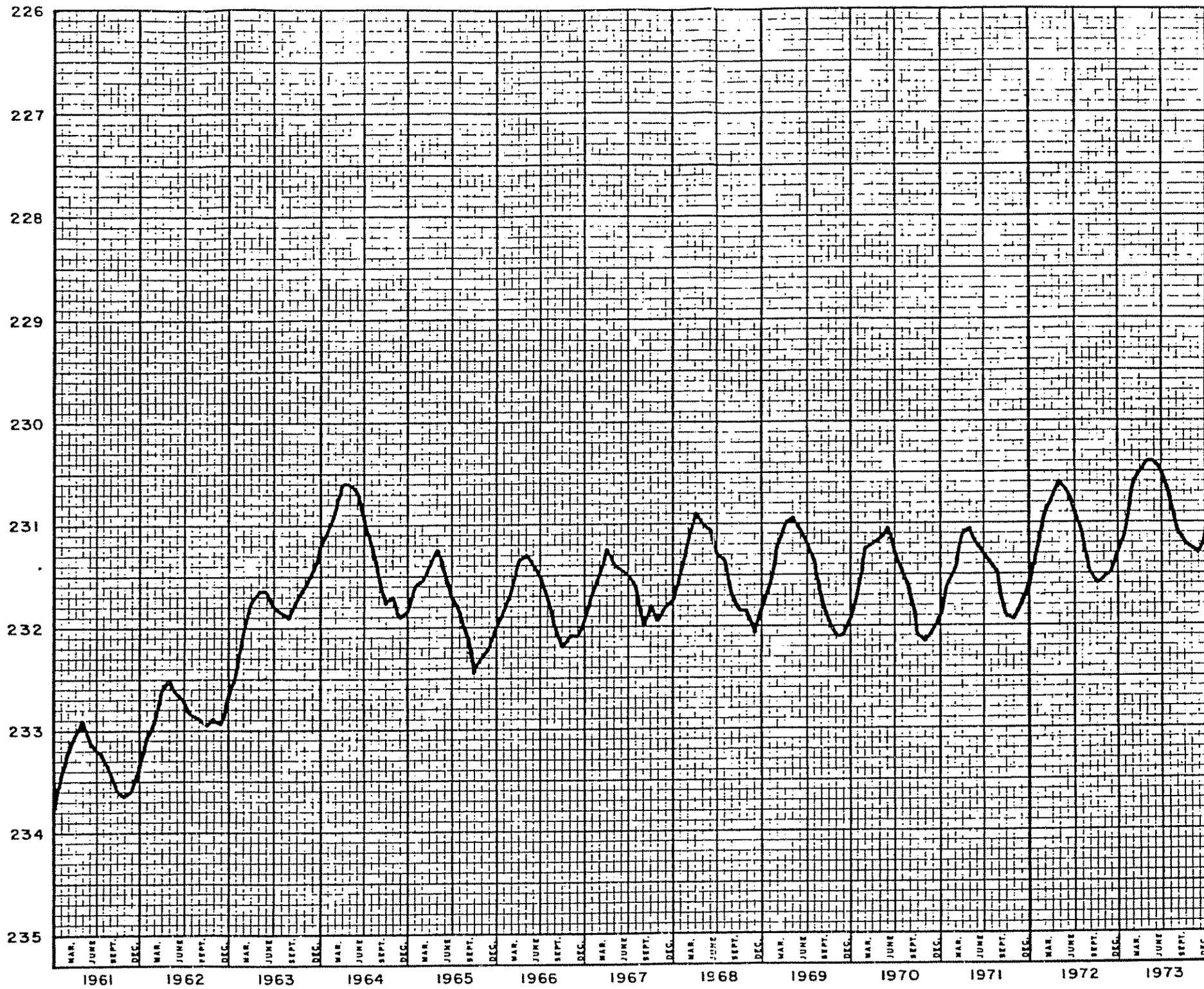
SOURCE : IMPERIAL IRRIGATION DISTRICT. (STATION NEAR FIG TREE JOHN SPRING)

HISTOR.



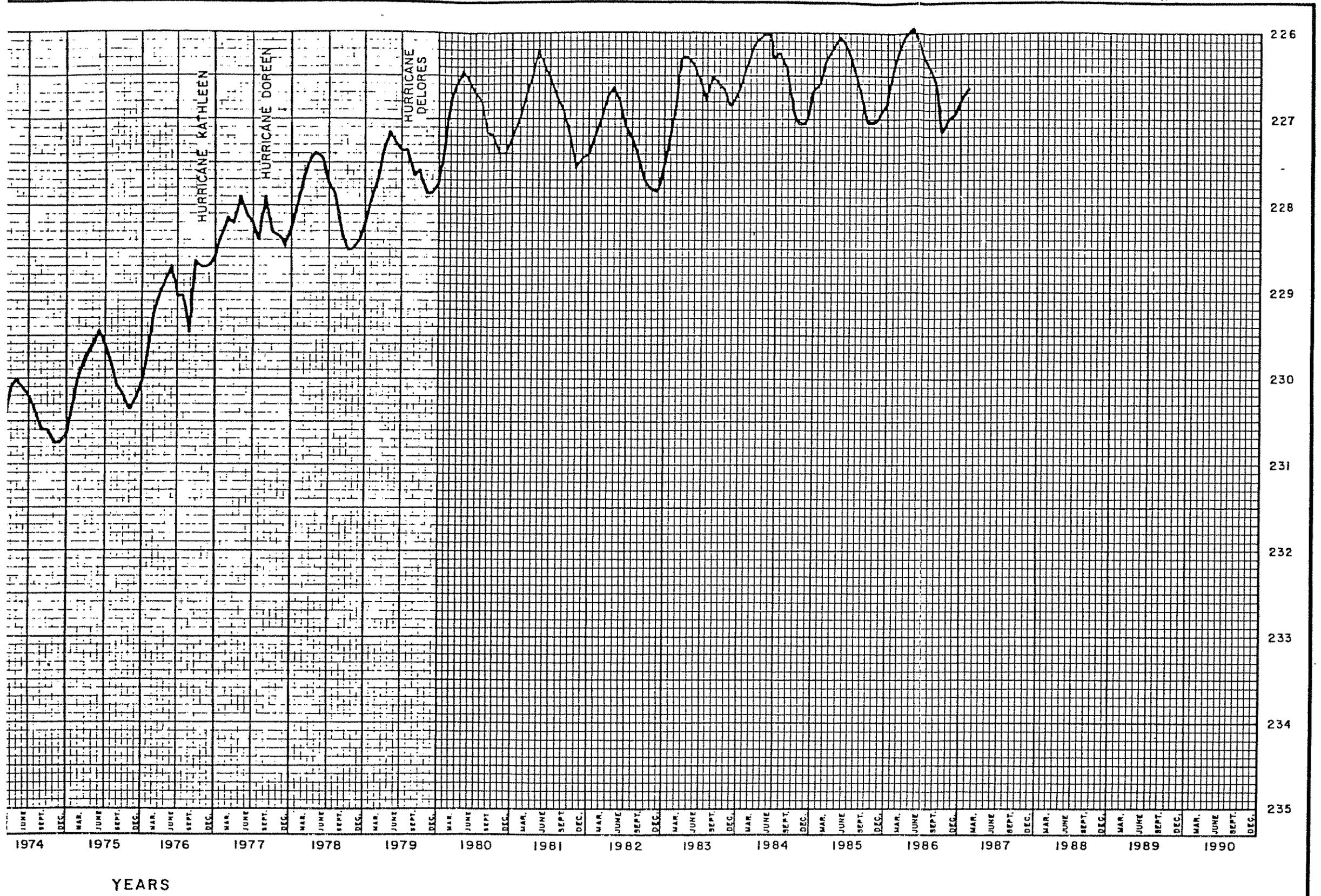
SALTON SEA
ANNUAL WATER SURFACE ELEVATIONS

WATER SURFACE ELEVATION
BELOW MEAN SEA LEVEL IN FEET

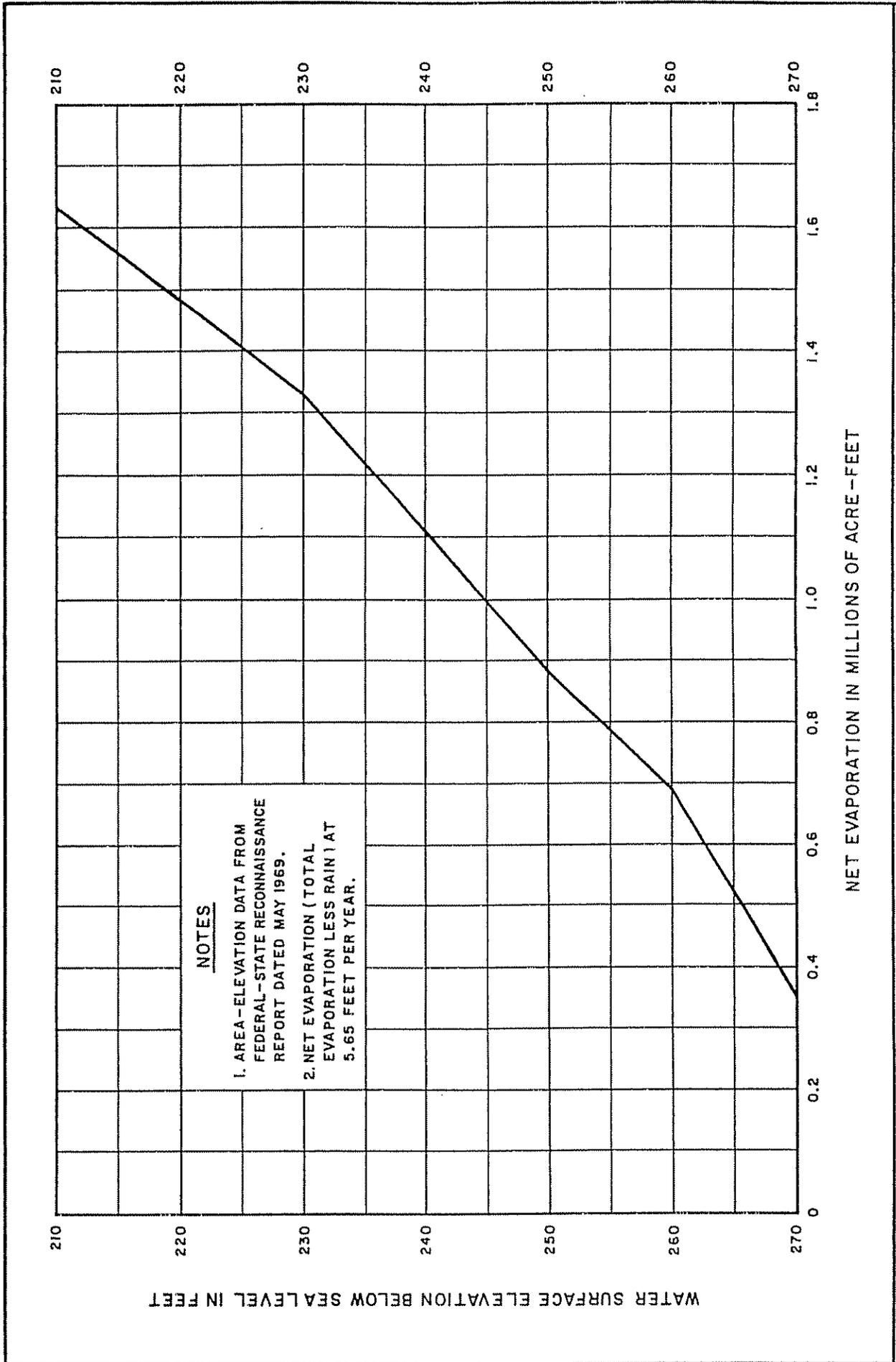


SOURCE: IMPERIAL IRRIGATION DISTRICT (NEAR FIG TREE JOHN SPRING)

WATE



SALTON SEA
SURFACE ELEVATIONS 1961-1986



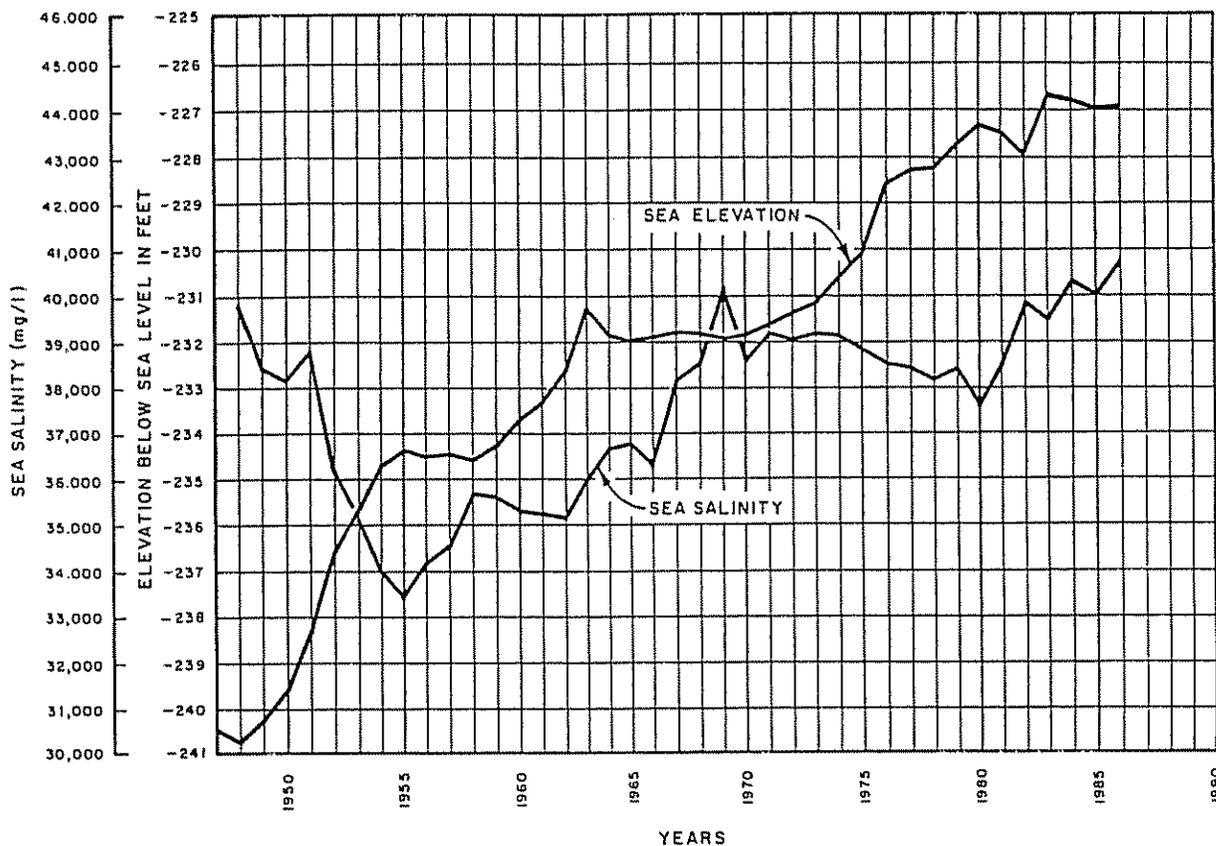
WATER SURFACE ELEVATION BELOW SEA LEVEL IN FEET

NOTES

- 1. AREA - ELEVATION DATA FROM FEDERAL - STATE RECONNAISSANCE REPORT DATED MAY 1969.
- 2. NET EVAPORATION (TOTAL EVAPORATION LESS RAIN) AT 5.65 FEET PER YEAR.

NET EVAPORATION IN MILLIONS OF ACRE - FEET

RELATIONSHIP BETWEEN SALTON SEA ELEVATION AND EVAPORATION



NOTES

1. END OF YEAR ELEVATIONS NEAR FIG TREE JOHN SPRING. (I.I.D. DATA)
2. AVERAGE OF SAMPLES AT FOUR OR FIVE STATIONS TAKEN IN MAY AND NOVEMBER BY I.I.D.

HISTORICAL CHANGE IN SALTON SEA'S SALINITY AND ELEVATION

HISTORIC SALTON SEA WATER BUDGET

Year (1)	Elevation Below Sea Level (2)	Surface Area in Thousands of Acres (3)	Water Balance in Thousands of Acre-Feet				Change in Storage (7)
			Inflow (4)	Direct Rain (5)	Evaporation (6)		
1949	240.2	192	-	-	-	-	
1950	239.6	195	1,191	3	1,077	+117	
1951	238.3	201	1,374	30	1,147	+257	
52	236.6	209	1,431	41	1,123	+349	
53	235.8	214	1,426	1	1,247	+180	
54	234.8	219	1,341	23	1,148	+216	
1955	234.4	221	1,357	17	1,285	+89	
1956	234.5	220	1,296	2	1,332	-33	
57	234.5	220	1,189	33	1,212	+11	
58	234.6	220	1,155	40	1,228	-33	
59	234.3	221	1,300	33	1,267	+66	
1960	233.8	224	1,383	36	1,296	+122	
1961	233.4	224	1,413	33	1,355	+91	
62	232.7	226	1,467	23	1,333	+157	
63	231.2	230	1,638	58	1,364	+332	
64	231.9	228	1,195	11	1,355	-149	
1965	232.0	228	1,171	49	1,256	-36	
1966	232.0	228	1,290	19	1,297	+12	
67	231.8	228	1,318	59	1,330	+47	
68	231.8	228	1,372	31	1,414	-11	
69	232.0	228	1,339	22	1,397	-35	
1970	231.9	228	1,268	21	1,277	+12	
1971	231.7	229	1,286	22	1,250	+57	
72	231.3	230	1,313	25	1,259	+80	
73	231.2	230	1,321	18	1,304	+35	
74	230.7	232	1,441	55	1,380	+116	
1975	230.1	233	1,452	14	1,328	+138	
1976	228.6	238	1,513	142	1,313	+341	
77	228.3	239	1,472	67	1,456	+83	
78	228.2	239	1,506	124	1,617	+13	
79	227.8	240	1,587	73	1,552	+108	
1980	227.3	241	1,469	88	1,438	+119	

HISTORIC SALTON SEA WATER BUDGET (Cont'd.)

Year (1)	Elevation Below Sea Level (2)	Surface Area in Thousands of Acres (3)	Water Balance in Thousands of Acre-Feet				Change in Storage (7)
			Inflow (4)	Direct Rain (5)	Evaporation (6)		
1981	227.4	241	1,292	48	1,376	-36	
82	227.6	241	1,194	64	1,294	-36	
83	226.6	243	1,442	162	1,387	+217	
84	226.7	243	1,338	55	1,404	-11	
1985	226.8	243	1,375	48	1,461	-38	
1986	226.8	243	1,199	65	1,252(8)	+12	

- (1) Calendar Year.
- (2) IID record of station near Fig Tree John Spring at end of year.
- (3) Salton Sea Area in thousands of acres.
- (4) Computed inflow to balance hydrologic equation. Inflow equals change in storage plus evaporation less direct rainfall.
- (5) Direct rain is computed as area times average rainfall as measured at three stations near Sea.
- (6) Evaporation is pan evaporation (average of three stations) times 0.69 times surface area. Values adjusted by correlation with Brawley stations for 1983-1984.
- (7) Determined from change in elevations and area-capacity relationship. Area-capacity relationship based on formula developed by the Aerospace Corporation (1971) adjusted to Fig Tree John Station.
- (8) Preliminary.

COMPONENTS OF INFLOW TO SALTON SEA
(Values in Thousands of Acre-Feet)

Year (1)	Imperial ID (2)	Mexico (3)	CVWD (4)	Other (5)	Total (6)
1950	1,085	45	73	-12	1,191
1951	1,149	44	116	65	1,374
52	1,241	44	94	52	1,431
53	1,326	39	71	-10	1,426
54	1,253	38	80	-30	1,341
1955	1,045	56	98	158	1,357
1956	1,062	85	89	60	1,296
57	976	80	76	57	1,189
58	934	113	84	24	1,155
59	976	131	90	103	1,300
1960	1,011	130	107	135	1,383
1961	997	124	126	166	1,413
62	1,030	141	160	138	1,467
63	1,090	148	185	215	1,638
64	836	113	178	68	1,195
1965	809	120	199	43	1,171
1966	931	112	193	54	1,290
67	954	105	191	68	1,318
68	927	114	198	133	1,372
69	889	112	204	134	1,339
1970	947	108	192	21	1,268
1971	1,019	116	200	-49	1,286
72	990	120	210	-7	1,313
73	991	126	225	-21	1,321
74	1,049	120	219	53	1,441
1975	1,054	108	236	54	1,452
1976	1,011	111	237	154	1,513
77	947	116	219	190	1,472
78	922	107	206	271	1,506
79	983	153	213	238	1,587
1980	969	165	206	129	1,469

COMPONENTS OF INFLOW TO SALTON SEA (Cont'd.)

(Values in Thousands of Acre-Feet)

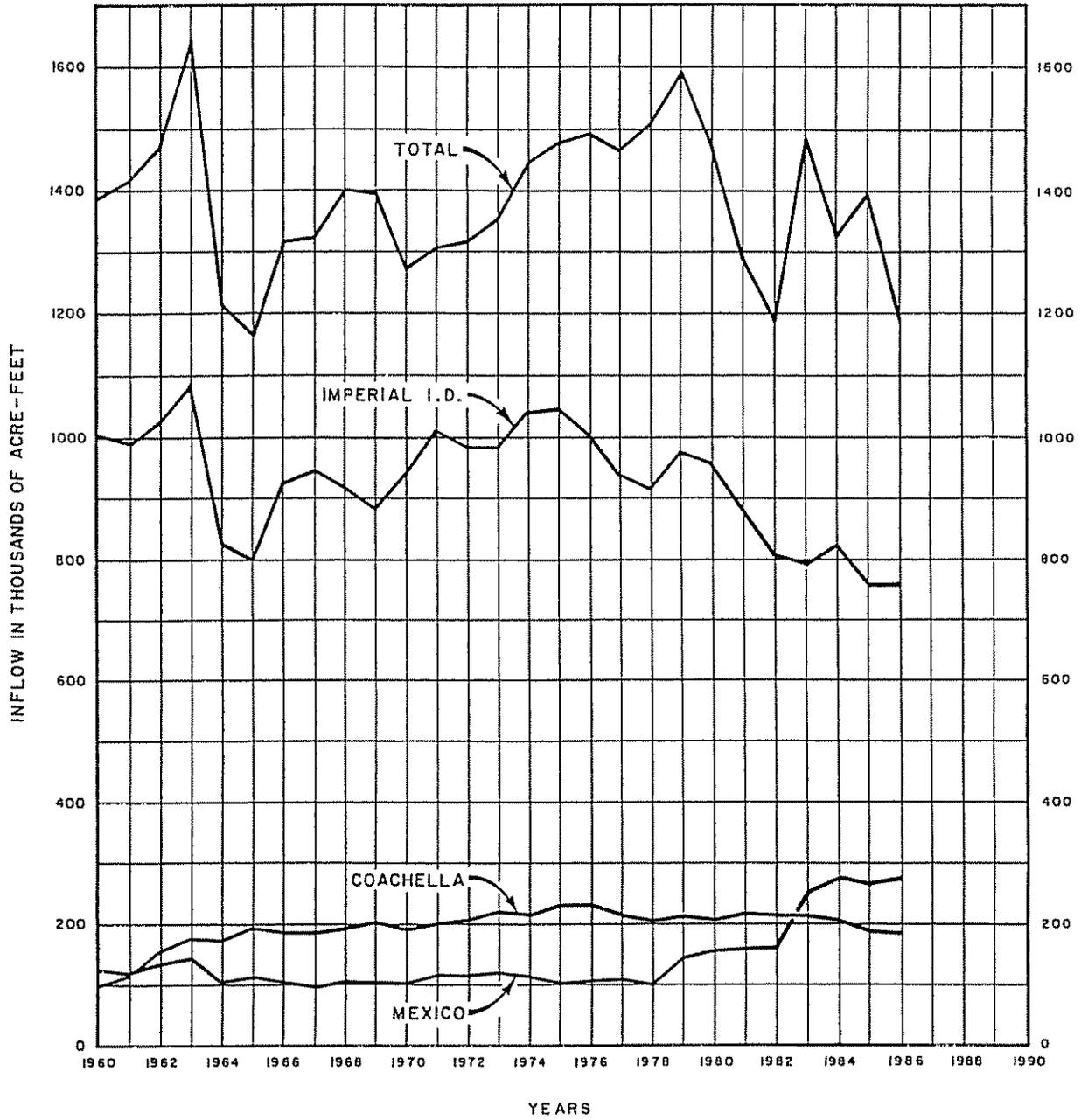
Year (1)	Imperial ID (2)	Mexico (3)	CVWD (4)	Other (5)	Total (6)
1981	889	165	219	19	1,292
82	815	166	214	-1	1,194
83	793	252	213	184	1,442
84	821	277	203	37	1,338
1985	757	269	186	163	1,375
1986	759	274	185	-19	1,199

- (1) Calendar year.
- (2) Amount as determined for IID adjusted for Coachella Canal seepage. The amount includes measured inflow in New and Alamo Rivers less surface and subsurface inflow from Mexico measured at boundary plus inflow from drains which empty directly to the Sea and subsurface inflow. An allowance for the Coachella Canal seepage entering the Salton Sea via IID was deducted. This amount was assumed to vary from 0 in 1954 to 54,000 acre-feet in 1965 and thereafter.
- (3) Inflow in New and Alamo Rivers measured at International Boundary plus subsurface inflow.
- (4) Values include an allowance for Coachella Canal seepage entering Salton Sea. The direct Coachella inflow was that reported by the USGS through 1972. From 1973 the amount was taken from Coachella Valley Water District data (form E-13-C), preliminary for 1985 and 1986.
- (5) Amount to balance table and includes storm inflow and subsurface inflow.
- (6) Total inflow computed from water balance of Salton Sea.

DERIVATION OF COMPONENTS TO SALTON SEA
(Values in Thousands of Acre-Feet)

Year (1)	Imperial Valley					Coachella Inflow			Total (9)
	Measured and Estimated Inflow in New and Alamo Rivers and Vicinity (2)	Less Inflow from Mexico (3)	Less Component from Coachella Canal (4)	Less Subsurface Inflow from West (5)	Imperial I.D. Inflow (6)	Coachella Valley Inflow (7)	Plus Coachella Canal (8)		
1950	1,145	45	-	15	1,085	65	8	73	
1951	1,208	44	-	15	1,149	108	8	116	
1952	1,300	44	-	15	1,241	86	8	94	
1953	1,380	39	-	15	1,326	63	8	71	
1954	1,306	38	0	15	1,253	72	8	80	
1955	1,121	56	5	15	1,045	85	13	98	
1956	1,172	85	10	15	1,062	71	18	89	
1957	1,086	80	15	15	976	53	23	76	
1958	1,082	113	20	15	934	56	28	84	
1959	1,147	131	25	15	976	57	33	90	
1960	1,185	130	29	15	1,011	70	37	107	
1961	1,170	124	34	15	997	84	42	126	
1962	1,225	141	39	15	1,030	113	47	160	
1963	1,297	148	44	15	1,090	133	52	185	
1964	1,013	113	49	15	836	121	57	178	
1965	998	120	54	15	809	137	62	199	
1966	1,112	112	54	15	931	131	62	193	
1967	1,128	105	54	15	954	129	62	191	
1968	1,110	114	54	15	927	136	62	198	
1969	1,070	112	54	15	889	142	62	204	
1970	1,124	108	54	15	947	130	62	192	
1971	1,204	116	54	15	1,019	138	62	200	
1972	1,179	120	54	15	990	148	62	210	
1973	1,186	126	54	15	991	163	62	225	
1974	1,238	120	54	15	1,049	157	62	219	
1975	1,231	108	54	15	1,054	174	62	236	
1976	1,291	111	54	15	1,011	175	62	237	
1977	1,132	116	54	15	947	157	62	219	
1978	1,098	107	54	15	922	144	62	206	
1979	1,205	153	54	15	983	151	62	213	
1980	1,203	165	54	15	969	144	62	206	
1981	1,123	165	54	15	889	157	62	219	
1982	1,050	166	54	15	815	152	62	214	
1983	1,114	252	54	15	793	151	62	213	
1984	1,167	277	54	15	821	141	62	203	
1985	1,095	269	54	15	757	124	62	186	
1986	1,102	274	54	15	759	123	62	185	

- (1) Calendar year.
- (2) Measured flow in New and Alamo Rivers at Salton Sea plus inflow from drains flowing directly into Sea plus subsurface inflow.
- (3) Measured surface flow of New and Alamo Rivers at International Boundary, plus subsurface inflow.
- (4) Portion of seepage from Coachella Canal estimated to enter Salton Sea via Imperial Valley.
- (5) Subsurface flow entering IID from west which is intercepted by drainage systems.
- (6) Column (2), less columns (3), (4), and (5).
- (7) Coachella inflow as reported by USGS through 1972. From 1973 amount taken from Coachella Valley Water District Form E-13-C, 1985 and 1986 are preliminary.
- (8) Column (4) plus estimated inflow north of IID.
- (9) Sum of columns (7) and (8).



COMPONENTS OF INFLOW TO SALTON SEA

OPERATION STUDIES OF SALTON SEA - 1950-1986

* = Historic Data

CALENDER YEAR	:INFLOW : :1000 AF:	PRECIP : Inches :	PAN EVAP: Inches :	ELEVATION: Feet	AREA : :1000 Ac	VOLUME : :1000 AF	SALT : :1000 Tons :	SALT : PPM
1949		*	*	*				
		1.86	100.20	-240.20	192.27	4120.01		
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5327.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.82	95.68	-234.45	220.50	5305.28	253287	35105
1958	1155	2.20	96.88	-234.60	219.71	5272.42	257371	35893
1959	1300	1.79	100.26	-234.30	221.29	5338.56	261968	36082
1960	1383	1.92	101.86	-233.75	224.20	5460.90	266858	35932
1961	1413	1.75	105.09	-233.35	224.12	5551.82	271854	36005
1962	1467	1.24	103.44	-232.65	226.04	5708.96	277041	35682
1963	1638	3.07	104.93	-231.20	230.11	6040.96	282833	34426
1964	1195	0.55	102.39	-231.85	228.28	5891.76	287059	35825
1965	1171	2.57	95.65	-232.00	227.85	5856.13	291200	36563
1966	1290	1.00	99.02	-231.95	227.99	5867.84	295761	37062
1967	1318	3.10	101.47	-231.75	228.56	5914.53	300421	37348
1968	1372	1.62	107.59	-231.80	228.43	5903.41	305272	38023
1969	1339	1.17	106.34	-231.95	227.99	5867.97	310007	38846
1970	1268	1.09	97.42	-231.90	228.13	5879.55	314491	39330
1971	1286	1.14	95.31	-231.65	228.84	5936.99	319038	39513
1972	1313	1.33	95.66	-231.30	229.81	6016.65	323681	39557
1973	1321	0.95	98.70	-231.15	230.24	6051.61	328352	39896
1974	1441	2.86	104.22	-230.65	231.66	6167.74	333447	39752
1975	1452	0.75	99.72	-230.05	233.35	6305.90	338581	39480
1976	1513	7.28	97.87	-228.60	237.53	6647.28	343931	38044
1977	1472	3.41	106.62	-228.25	238.55	6730.55	349136	38142
1978	1506	6.24	117.89	-228.20	238.71	6743.55	354461	38649
1979	1587	3.67	113.04	-227.75	240.04	6851.99	360073	38640
1980	1469	4.42	104.22	-227.25	241.49	6970.94	365267	38528
1981	1292	2.37	99.06	-227.40	241.06	6935.10	369836	39212
1982	1194	3.17	93.35	-227.55	240.61	6898.89	374058	39868
1983	1442	8.10	100.26	-226.65	243.27	7116.19	379157	39177
1984	1338	2.69	100.35	-226.70	243.14	7105.02	383888	39728
1985	1375	2.35	104.47	-226.85	242.67	7067.12	388750	40447
1986	1199	3.22	89.71	-226.80	242.82	7079.46	392990	40817

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Without Mexico

CALENDER YEAR	:INFLOW :1000 AF:	PRECIP Inches	PAN EVAP Inches	ELEVATION Feet	AREA :1000 Ac	VOLUME :1000 AF	SALT :1000 tons	SALT PPM
1949		*	*	*	192.27	4120.01		
1950	1146	0.20	97.43	-239.83	193.98	4192.10	220000	38588
1951	1330	1.82	102.25	-238.71	199.20	4411.02	224703	37457
1952	1387	2.46	97.07	-237.16	206.72	4727.03	229607	35716
1953	1387	0.06	103.54	-236.40	210.47	4884.33	234511	35304
1954	1303	1.28	93.39	-235.48	215.12	5079.58	239118	34614
1955	1301	0.93	102.08	-235.23	216.43	5134.58	243718	34901
1956	1211	0.13	104.79	-235.65	214.27	5043.85	248000	36154
1957	1109	1.82	95.68	-235.83	213.38	5006.53	251921	36999
1958	1042	2.20	96.88	-236.33	210.82	4899.00	255606	38364
1959	1169	1.79	100.26	-236.40	210.46	4884.08	259740	39104
1960	1253	1.92	101.86	-236.15	211.75	4938.09	264171	39336
1961	1299	1.75	105.09	-235.96	212.71	4978.44	268729	39690
1962	1326	1.24	103.44	-235.57	214.68	5061.26	273418	39722
1963	1490	3.07	104.93	-234.42	220.63	5310.90	278687	38584
1964	1082	0.55	102.39	-235.37	215.70	5104.08	282513	40699
1965	1051	2.57	95.65	-235.79	213.58	5014.94	286229	41967
1966	1178	1.00	99.02	-235.88	213.10	4994.69	290394	42750
1967	1213	3.10	101.47	-235.76	213.69	5019.42	294683	43168
1968	1258	1.62	107.59	-235.93	212.85	4984.31	299131	44128
1969	1227	1.17	106.34	-236.18	211.57	4930.58	303470	45256
1970	1160	1.09	97.42	-236.21	211.43	4924.65	307572	45923
1971	1170	1.14	95.31	-236.06	212.18	4956.03	311709	46246
1972	1193	1.33	95.66	-235.83	213.36	5005.48	315927	46409
1973	1195	0.95	98.70	-235.83	213.38	5006.53	320153	47020
1974	1321	2.86	104.22	-235.39	215.60	5099.68	324824	46835
1975	1344	0.75	99.72	-234.83	218.49	5220.94	329576	46416
1976	1402	7.28	97.87	-233.46	225.75	5525.95	334533	44514
1977	1356	3.41	106.62	-233.30	224.25	5562.11	339328	44858
1978	1399	6.24	117.89	-233.32	224.19	5557.62	344275	45549
1979	1434	3.67	113.04	-233.12	224.75	5602.99	349346	45846
1980	1304	4.43	104.22	-232.94	225.24	5642.94	353957	46122
1981	1127	2.37	99.06	-233.44	223.87	5531.49	357942	47581
1982	1028	3.17	93.35	-233.95	222.47	5416.97	361577	49080
1983	1190	8.10	100.26	-233.70	223.18	5474.61	365785	49129
1984	1061	2.69	100.35	-234.49	221.01	5297.89	369537	51288
1985	1106	2.35	104.47	-235.30	216.07	5119.55	373448	53636
1986	925	3.22	89.71	-235.91	212.94	4987.96	376719	55534

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Without Coachella

CALENDAR YEAR	: INFLOW : : 1000 AF:	PRECIP : Inches :	PAN EVAP: Inches :	ELEVATION: Feet :	AREA : : 1000 Ac :	VOLUME : : 1000 AF :	SALT : : 1000 tons :	SALT : PPM :
1949		1.86	100.20	-240.20	192.27	4120.01		
1950	1118	0.20	97.43	-239.97	193.32	4164.10	220000	38847
1951	1258	1.82	102.25	-239.20	196.91	4314.84	224448	38248
1952	1337	2.46	97.07	-237.81	203.54	4593.17	229176	36687
1953	1355	0.06	103.54	-237.11	206.97	4737.43	233967	36314
1954	1261	1.28	93.39	-236.28	211.06	4909.09	238426	35712
1955	1259	0.93	102.08	-236.11	211.93	4945.61	242878	36110
1956	1207	0.13	104.79	-236.43	210.32	4877.95	247146	37254
1957	1113	1.82	95.68	-236.49	210.03	4865.77	251082	37942
1958	1071	2.20	96.88	-236.78	208.59	4805.29	254869	38999
1959	1210	1.79	100.26	-236.59	209.51	4843.92	259148	39338
1960	1276	1.92	101.86	-236.20	211.47	4926.36	263660	39353
1961	1387	1.75	105.09	-236.01	212.42	4966.36	268211	39710
1962	1307	1.24	103.44	-235.71	213.98	5031.86	272833	39868
1963	1453	3.07	104.93	-234.71	219.14	5248.54	277971	38942
1964	1017	0.55	102.39	-235.92	212.88	4985.40	281567	41528
1965	972	2.57	95.65	-236.65	209.33	4832.20	285004	43368
1966	1097	1.00	99.02	-237.02	207.40	4755.36	288883	44668
1967	1127	3.10	101.47	-237.16	206.70	4725.87	292868	45567
1968	1174	1.62	107.59	-237.53	204.87	4649.07	297019	46976
1969	1135	1.17	106.34	-238.01	202.54	4551.29	301032	48633
1970	1076	1.09	97.42	-238.21	201.58	4511.22	304837	49686
1971	1086	1.14	95.31	-238.21	201.59	4511.63	308677	50307
1972	1103	1.33	95.66	-238.13	201.99	4528.13	312577	50757
1973	1096	0.95	98.70	-238.30	201.17	4493.80	316452	51779
1974	1222	2.86	104.22	-237.98	202.70	4558.21	320773	51745
1975	1216	0.75	99.72	-237.65	204.28	4624.61	325073	51685
1976	1276	7.28	97.87	-236.45	210.25	4874.93	329585	49712
1977	1253	3.41	106.62	-236.33	210.81	4898.73	334016	50135
1978	1300	6.24	117.89	-236.43	210.35	4879.33	338613	51028
1979	1374	3.67	113.04	-236.09	212.04	4950.43	343471	51016
1980	1263	4.42	104.22	-235.76	213.72	5020.83	347937	50955
1981	1073	2.37	99.06	-236.24	211.39	4918.70	351731	52580
1982	980	3.17	93.35	-236.71	208.95	4820.40	355196	54181
1983	1229	8.10	100.26	-235.92	212.89	4985.87	359542	53024
1984	1135	2.69	100.35	-236.14	211.80	4940.20	363555	54111
1985	1189	2.35	104.47	-236.34	210.80	4898.39	367759	55204
1986	1014	3.22	89.71	-236.41	210.40	4881.56	371345	55935

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Imperial Irrigation District Inflow Only

CALENDER YEAR	:INFLOW : :1000 AF:	PRECIP : Inches :	PAN EVAP: Inches :	ELEVATION: Feet	AREA : :1000 Ac	:VOLUME : :1000 AF	SALT : :1000 Tons :	SALT : PPM
1949		*	*	*				
1950	1085	0.20	100.20	-240.20	192.27	4120.01		
1951	1149	1.82	97.43	-240.14	192.53	4131.10	220000	39158
1952	1241	1.82	102.25	-239.90	193.63	4177.34	224063	39440
1953	1326	2.46	97.07	-238.88	198.39	4377.27	228451	38375
1954	1326	0.06	103.54	-238.15	201.87	4523.12	233140	37900
1954	1253	1.28	93.39	-237.22	206.40	4713.64	237571	37059
1955	1045	0.93	102.08	-237.96	202.82	4563.13	241266	38877
1956	1062	0.13	104.79	-238.74	199.06	4405.25	245021	40897
1957	976	1.82	95.68	-239.19	196.94	4316.30	248472	42328
1958	934	2.20	96.88	-239.84	193.92	4189.33	251775	44191
1959	976	1.79	100.26	-240.43	191.23	4076.33	255226	46038
1960	1011	1.92	101.86	-240.84	189.36	3997.93	258801	47598
1961	997	1.75	105.09	-241.48	186.51	3878.31	262326	49735
1962	1030	1.24	103.44	-241.80	185.08	3818.25	265968	51218
1963	1090	3.07	104.93	-241.69	185.57	3838.93	269822	51681
1964	836	0.55	102.39	-242.05	179.67	3590.89	272778	55856
1965	609	2.57	95.65	-243.84	176.32	3450.24	275639	56743
1966	931	1.00	99.02	-244.17	174.93	3392.05	278931	60464
1967	954	3.10	101.47	-244.29	174.42	3370.61	282304	61584
1968	927	1.62	107.59	-245.03	171.36	3242.13	285582	64768
1969	889	1.17	106.34	-245.87	167.98	3100.06	288726	68482
1970	947	1.09	97.42	-245.74	168.48	3121.38	292075	68803
1971	1019	1.14	95.31	-245.09	171.14	3233.04	295678	67246
1972	990	1.33	95.66	-244.69	172.75	3300.65	299179	66649
1973	991	0.95	98.70	-244.55	173.33	3324.92	302683	66937
1974	1049	2.86	104.22	-244.26	174.56	3376.52	306392	66722
1975	1054	0.75	99.72	-243.89	176.08	3440.53	310119	66277
1976	1011	7.28	97.87	-243.18	179.11	3567.43	313694	64656
1977	947	3.41	106.62	-243.74	176.72	3467.29	317043	67234
1978	922	6.24	117.89	-244.79	172.34	3283.25	320303	71733
1979	983	3.67	113.04	-245.29	170.33	3198.80	323779	74426
1980	969	4.42	104.22	-245.22	170.59	3209.82	327205	74955
1981	889	2.37	99.06	-245.51	169.42	3160.85	330349	76848
1982	815	3.17	93.35	-245.80	168.24	3111.21	333231	78755
1983	793	8.10	100.26	-246.18	166.73	3047.87	336035	81068
1984	821	2.69	100.35	-246.81	164.26	2944.18	338938	84648
1985	757	2.35	104.47	-248.03	159.56	2746.62	341615	91453
1986	759	3.22	89.71	-248.16	159.05	2725.38	344299	92890

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Less Recent Storms
and Increase in Mexico over 100,000 Acre-feet per Year

CALENDER YEAR	:INFLOW : :1000 AF:	PRECIP : Inches :	PAN EVAP: Inches :	ELEVATION: Feet	AREA : :1000 Ac	:VOLUME : :1000 AF	: SALT : :1000 Tons :	: SALT : PPM
1949		*	*	*				
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5337.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.82	95.68	-234.45	220.50	5305.28	253287	35105
1958	1142	2.20	96.88	-234.66	219.40	5259.42	257325	35975
1959	1269	1.79	100.26	-234.49	220.28	5296.30	261812	36348
1960	1353	1.92	101.86	-234.05	222.62	5394.37	266596	36339
1961	1389	1.75	105.09	-233.71	223.13	5470.64	271508	36493
1962	1426	1.24	103.44	-233.17	224.62	5592.59	276550	36360
1963	1590	3.07	104.93	-231.88	228.20	5884.82	282172	35257
1964	1182	0.55	102.39	-232.54	226.35	5733.78	286352	36721
1965	1151	2.57	95.65	-232.74	225.79	5688.37	290422	37541
1966	1278	1.00	99.02	-232.69	225.93	5699.61	294941	38050
1967	1313	3.10	101.47	-232.46	226.58	5752.78	299584	38291
1968	1358	1.62	107.59	-232.52	226.42	5739.64	304386	38994
1969	1327	1.17	106.34	-232.67	225.99	5704.26	309078	39841
1970	1260	1.09	97.42	-232.61	226.17	5718.89	313533	40312
1971	1270	1.14	95.31	-232.38	226.80	5770.91	318024	40521
1972	1293	1.33	95.66	-232.07	227.67	5841.54	322596	40606
1973	1295	0.95	98.70	-231.98	227.92	5862.49	327175	41035
1974	1421	2.86	104.22	-231.50	229.26	5971.94	332200	40902
1975	1444	0.75	99.72	-230.87	231.02	6115.70	337306	40555
1976	1214	7.28	97.87	-230.64	231.69	6169.76	341599	40711
1977	1264	3.41	106.62	-231.03	230.58	6079.22	346069	41858
1978	1461	6.24	117.89	-230.95	230.80	6097.11	351235	42358
1979	1534	3.67	113.04	-230.50	232.08	6201.57	356659	42288
1980	1298	4.42	104.22	-230.53	231.99	6194.31	361249	42882
1981	1227	2.37	99.06	-230.74	231.39	6145.74	365588	43740
1982	1085	3.17	93.35	-231.16	230.22	6049.85	369425	44900
1983	1054	8.10	100.26	-231.67	228.78	5932.06	373152	46253
1984	1117	2.69	100.35	-232.34	226.92	5780.28	377102	47970
1985	1206	2.35	104.47	-232.83	225.54	5667.62	381366	49477
1986	1025	3.22	89.71	-233.18	224.59	5589.74	384990	50643

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Less 100,000 Acre-feet
Per Year Since 1950

CALENDER YEAR	: INFLOW : : 1000 AF:	PRECIP : : Inches :	PAN EVAP : : Inches :	ELEVATION : : Feet :	AREA : : 1000 Ac :	VOLUME : : 1000 AF :	SALT : : 1000 Tons :	SALT : : PPM :
1949		1.86	100.20	-240.20	192.27	4120.01		
1950	1091	0.20	97.43	-240.11	192.67	4137.10	220000	39101
1951	1274	1.82	102.25	-239.24	196.73	4307.52	224505	38323
1952	1331	2.46	97.07	-237.87	203.24	4580.79	229211	36792
1953	1326	0.06	103.54	-237.30	206.03	4697.80	233900	36610
1954	1241	1.28	93.39	-236.54	209.76	4854.43	238288	36093
1955	1257	0.93	102.08	-236.34	210.76	4896.50	242733	36451
1956	1196	0.13	104.79	-236.69	209.05	4824.87	246962	37636
1957	1089	1.82	95.68	-236.83	208.35	4795.45	250813	38458
1958	1055	2.20	96.88	-237.15	206.75	4728.00	254543	39586
1959	1300	1.79	100.26	-236.96	207.67	4766.96	258786	39917
1960	1283	1.92	101.86	-236.48	210.05	4866.85	263323	39783
1961	1313	1.75	105.09	-236.13	211.82	4941.30	267966	39876
1962	1367	1.24	103.44	-235.53	214.90	5070.20	272800	39562
1963	1538	2.07	104.93	-234.17	221.95	5366.61	278238	38122
1964	1095	0.55	102.39	-235.09	219.39	5165.04	282110	40161
1965	1071	2.57	95.65	-235.50	215.04	5076.44	285897	41411
1966	1190	1.00	99.02	-235.58	214.65	5059.97	290105	42157
1967	1218	3.10	101.47	-235.48	215.15	5081.03	294412	42605
1968	1272	1.62	107.59	-235.62	214.44	5051.04	298910	43513
1969	1239	1.17	106.34	-235.86	213.22	4999.75	303291	44604
1970	1168	1.09	97.42	-235.89	213.05	4992.74	307421	45275
1971	1186	1.14	95.31	-235.71	213.97	5031.39	311615	45540
1972	1213	1.33	95.66	-235.43	215.40	5091.17	315904	45625
1973	1221	0.95	98.70	-235.36	215.77	5106.80	320221	46107
1974	1341	2.86	104.22	-234.90	218.14	5206.21	324963	45896
1975	1352	0.75	99.72	-234.38	220.87	5321.07	329744	45566
1976	1413	7.28	97.87	-233.02	228.11	5625.11	334740	43756
1977	1372	3.41	106.62	-232.85	225.49	5663.46	339591	44090
1978	1406	6.24	117.89	-232.88	225.42	5658.21	344563	44777
1979	1487	3.67	113.04	-232.47	226.53	5748.95	349821	44742
1980	1369	4.42	104.22	-232.06	227.70	5843.85	354662	44625
1981	1192	2.37	99.06	-232.32	226.96	5783.88	358877	45623
1982	1094	3.17	93.35	-232.60	226.17	5719.59	362745	46633
1983	1342	8.10	100.26	-231.77	228.51	5910.38	367490	45718
1984	1238	2.69	100.35	-231.89	228.15	5881.07	371868	46494
1985	1275	2.35	104.47	-232.12	227.53	5830.24	376376	47468
1986	1099	3.22	89.71	-232.18	227.36	5816.63	380262	48070

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Less 100,000 Acre-feet
Per Year Since 1960

CALENDER YEAR	:INFLOW : :1000 AF:	PRECIP : Inches :	PAN EVAP: Inches :	ELEVATION: Feet :	AREA : :1000 Ac :	VOLUME : :1000 AF :	SALT : :1000 Tons :	SALT : PPM :
1949		* 1.86	* 100.20	* -240.20	192.27	4120.01		
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5327.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.62	95.68	-234.45	220.50	5305.28	253287	35105
1958	1155	2.20	96.88	-234.60	219.71	5272.42	257371	35893
1959	1300	1.79	100.26	-234.30	221.29	5338.56	261968	36082
1960	1283	1.92	101.86	-234.20	221.82	5360.90	266505	36553
1961	1313	1.75	105.09	-234.17	221.94	5365.87	271148	37156
1962	1367	1.24	103.44	-233.87	222.70	5435.76	275982	37332
1963	1538	3.07	104.93	-232.75	225.78	5687.08	281420	36385
1964	1095	0.55	102.39	-233.75	223.04	5463.19	285292	38398
1965	1071	2.57	95.65	-234.23	221.71	5255.29	289079	39691
1966	1190	1.00	99.02	-234.47	220.40	5301.41	293287	40678
1967	1218	3.10	101.47	-234.52	220.14	5290.40	297594	41362
1968	1272	1.62	107.59	-234.79	218.71	5230.24	302092	42470
1969	1239	1.17	106.34	-235.14	216.87	5153.27	306473	43729
1970	1168	1.09	97.42	-235.27	216.23	5126.12	310603	44553
1971	1186	1.14	95.31	-235.17	216.74	5147.66	314797	44966
1972	1213	1.33	95.66	-234.96	217.81	5192.51	319086	45185
1973	1221	0.95	98.70	-234.95	217.86	5194.63	323403	45777
1974	1341	2.86	104.22	-234.55	219.94	5282.00	328145	45680
1975	1352	0.75	99.72	-234.08	222.43	5386.63	332926	45446
1976	1413	7.28	97.87	-232.77	225.72	5682.83	337922	43723
1977	1372	3.41	106.62	-232.54	226.37	5735.14	342773	43946
1978	1406	6.24	117.89	-232.58	226.23	5724.40	347745	44668
1979	1487	3.67	113.04	-232.21	227.28	5810.12	353003	44674
1980	1369	4.42	104.22	-231.81	228.39	5900.81	357844	44591
1981	1192	2.37	99.06	-232.09	227.61	5837.00	362059	45609
1982	1094	3.17	93.35	-232.38	226.78	5769.39	365927	46636
1983	1342	8.10	100.26	-231.56	229.08	5957.08	370672	45753
1984	1238	2.69	100.35	-231.70	228.68	5924.60	375050	46547
1985	1275	2.35	104.47	-231.94	228.02	5870.67	379558	47539
1986	1099	3.22	89.71	-232.01	227.83	5854.63	383444	48157

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Less 100,000 Acre-feet
Per Year Since 1965

CALENDER YEAR	:INFLOW :1000 AF:	PRECIP Inches	PAN EVAP Inches	ELEVATION Feet	AREA :1000 Ac	VOLUME :1000 AF	SALT :1000 Tons	SALT PPM
		*	*	*				
1949		1.86	100.20	-240.20	192.27	4120.01		
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5327.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.82	95.68	-234.45	220.50	5305.28	253287	35105
1958	1155	2.20	96.88	-234.60	219.71	5272.42	257371	35893
1959	1300	1.79	100.26	-234.30	221.29	5338.56	261968	36082
1960	1383	1.92	101.86	-233.75	224.20	5460.90	266858	35932
1961	1413	1.75	105.09	-233.35	224.12	5551.82	271854	36005
1962	1467	1.24	103.44	-232.65	226.04	5708.96	277041	35682
1963	1638	3.07	104.93	-231.20	230.11	6040.96	282833	34426
1964	1195	0.55	102.39	-231.85	228.28	5891.76	287059	35825
1965	1071	2.57	95.65	-232.44	226.62	5756.13	290846	37153
1966	1190	1.00	99.02	-232.80	225.63	5674.71	295054	38231
1967	1218	3.10	101.47	-232.98	225.13	5634.58	299361	39066
1968	1272	1.62	107.59	-233.38	224.03	5544.20	303859	40299
1969	1239	1.17	106.34	-233.87	222.69	5435.22	308240	41700
1970	1168	1.09	97.42	-234.14	221.97	5376.00	312370	42724
1971	1186	1.14	95.31	-234.18	221.85	5366.63	316564	43373
1972	1213	1.33	95.66	-234.10	222.07	5383.93	320853	43820
1973	1221	0.95	98.70	-234.20	221.80	5362.23	325170	44589
1974	1341	2.86	104.22	-233.90	223.39	5426.93	329912	44700
1975	1352	0.75	99.72	-233.53	223.63	5511.99	334693	44648
1976	1413	7.28	97.87	-232.24	227.19	5802.16	339689	43048
1977	1372	3.41	106.62	-232.05	227.72	5845.92	344540	43336
1978	1406	6.24	117.89	-232.13	227.49	5826.69	349512	44106
1979	1487	3.67	113.04	-231.79	228.44	5904.66	354770	44179
1980	1369	4.42	104.22	-231.42	229.47	5988.84	359611	44152
1981	1192	2.37	99.06	-231.73	228.62	5919.11	363826	45196
1982	1094	3.17	93.35	-232.05	227.73	5846.37	367694	46245
1983	1342	8.10	100.26	-231.25	229.97	6029.26	372439	45421
1984	1238	2.69	100.35	-231.41	229.51	5991.88	376817	46241
1985	1275	2.35	104.47	-231.67	228.79	5933.17	381325	47257
1986	1099	3.22	89.71	-231.75	228.55	5913.39	385211	47899

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Less 100,000 Acre-feet
Per Year Since 1975

CALENDER YEAR	: INFLOW : 1000 AF	: PRECIP : Inches	: PAN EVAP : Inches	: ELEVATION : Feet	: AREA : 1000 Ac	: VOLUME : 1000 AF	: SALT : 1000 Tons	: SALT : PPM
1949		1.86	100.20	-240.20	192.27	4120.01		
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5327.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.82	95.68	-234.45	220.50	5305.28	253287	35105
1958	1155	2.20	96.88	-234.60	219.71	5272.42	257371	35893
1959	1300	1.79	100.26	-234.30	221.29	5338.56	261968	36082
1960	1383	1.92	101.86	-233.75	224.20	5460.90	266858	35932
1961	1413	1.75	105.09	-233.35	224.12	5551.82	271854	36005
1962	1467	1.24	103.44	-232.65	226.04	5708.96	277041	35682
1963	1638	3.07	104.93	-231.20	230.11	6040.96	282833	34426
1964	1195	0.55	102.39	-231.85	228.28	5891.76	287059	35835
1965	1171	2.57	95.65	-232.00	227.85	5856.13	291200	36563
1966	1290	1.00	99.02	-231.95	227.99	5867.84	295761	37062
1967	1318	3.10	101.47	-231.75	228.56	5914.53	300421	37348
1968	1372	1.62	107.59	-231.80	228.43	5903.41	305272	38023
1969	1339	1.17	106.34	-231.95	227.99	5867.97	310007	38846
1970	1268	1.09	97.42	-231.90	228.13	5879.55	314491	39330
1971	1286	1.14	95.31	-231.65	228.84	5936.99	319038	39513
1972	1313	1.33	95.66	-231.30	229.81	6016.65	323681	39557
1973	1321	0.95	98.70	-231.15	230.24	6051.61	328352	39896
1974	1441	2.86	104.22	-230.65	231.66	6167.74	333447	39752
1975	1352	0.75	99.72	-230.48	232.13	6205.90	338228	40074
1976	1413	7.28	97.87	-229.42	235.16	6453.42	343224	39106
1977	1372	3.41	106.62	-229.44	235.12	6450.57	348075	39677
1978	1406	6.24	117.89	-229.71	234.32	6385.02	353047	40657
1979	1487	3.67	113.04	-229.56	234.76	6420.65	358305	41033
1980	1369	4.42	104.22	-229.36	235.35	6469.30	363146	41275
1981	1192	2.37	99.06	-229.79	234.10	6367.23	367361	42423
1982	1094	3.17	93.35	-230.22	232.87	6266.49	371229	43559
1983	1342	8.10	100.26	-229.55	234.79	6423.20	375974	43040
1984	1238	2.69	100.35	-229.83	234.00	6359.08	380352	43980
1985	1275	2.35	104.47	-230.19	232.96	6274.24	384860	45103
1986	1099	3.22	89.71	-230.36	232.47	6234.05	388746	45852

OPERATION STUDIES OF SALTON SEA - 1950-1986

Assumed Inflow Condition: Historic Inflow Plus 100,000 Acre-feet
Per Year Since January 1965

CALENDER YEAR	:INFLOW :1000 AF:	PRECIP Inches	PAN EVAP Inches	ELEVATION Feet	AREA :1000 Ac	VOLUME :1000 AF	SALT :1000 Tons	SALT PFM
1949		1.86	100.20	-240.20	192.27	4120.01		
1950	1191	0.20	97.43	-239.60	195.06	4237.10	220000	38178
1951	1374	1.82	102.25	-238.30	201.17	4493.88	224858	36792
1952	1431	2.46	97.07	-236.60	209.49	4843.28	229918	34906
1953	1426	0.06	103.54	-235.75	213.77	5023.11	234960	34394
1954	1341	1.28	93.39	-234.75	218.92	5238.96	239702	33642
1955	1357	0.93	102.08	-234.35	221.04	5327.98	244500	33742
1956	1296	0.13	104.79	-234.50	220.24	5294.55	249083	34592
1957	1189	1.82	95.68	-234.45	220.50	5305.28	253287	35105
1958	1155	2.20	96.88	-234.60	219.71	5272.42	257371	35893
1959	1300	1.79	100.26	-234.30	221.29	5338.56	261968	36082
1960	1383	1.92	101.86	-233.75	224.20	5460.90	266858	35932
1961	1413	1.75	105.09	-233.35	224.12	5551.82	271854	36005
1962	1467	1.24	103.44	-232.65	226.04	5708.96	277041	35682
1963	1638	3.07	104.93	-231.20	230.11	6040.96	282833	34426
1964	1195	0.55	102.39	-231.85	228.28	5891.76	287059	35825
1965	1271	2.57	95.65	-231.57	229.07	5956.13	291553	35993
1966	1390	1.00	99.02	-231.11	230.35	6060.98	296468	35966
1967	1418	3.10	101.47	-230.53	231.99	6194.49	301482	35786
1968	1472	1.62	107.59	-230.24	232.82	6262.63	306887	36008
1969	1439	1.17	106.34	-230.08	233.29	6300.73	311775	36384
1970	1368	1.09	97.42	-229.72	234.30	6383.12	316612	36472
1971	1386	1.14	95.31	-229.19	235.82	6507.35	321513	36329
1972	1413	1.33	95.66	-228.59	237.56	6649.38	326509	36106
1973	1421	0.95	98.70	-228.21	238.68	6741.00	331534	36163
1974	1541	2.86	104.22	-227.51	240.73	6908.57	336983	35866
1975	1552	0.75	99.72	-226.74	243.02	7095.29	342471	35491
1976	1613	7.28	97.87	-225.14	247.83	7488.14	348175	34189
1977	1572	3.41	106.62	-224.64	249.33	7611.24	353734	34173
1978	1606	6.24	117.89	-224.46	249.89	7656.75	359413	34515
1979	1687	3.67	113.04	-223.90	251.59	7795.94	365378	34482
1980	1569	4.42	104.22	-223.29	253.48	7949.91	370926	34307
1981	1392	2.37	99.06	-223.30	253.46	7948.17	375848	34770
1982	1294	3.17	93.35	-223.30	253.46	7948.67	380424	35191
1983	1542	8.10	100.26	-222.31	256.55	8200.55	385877	34599
1984	1438	2.69	100.35	-222.25	256.73	8215.76	390962	34990
1985	1475	2.35	104.47	-222.32	256.53	8198.84	396178	35530
1986	1299	3.22	89.71	-222.15	257.07	8243.44	400771	35748

OPERATION STUDIES OF SALTON SEA - 1960-1986

Assumed Inflow Condition: Historic Inflow with One Foot of
Water Added in 1961

CALENDER YEAR	:INFLOW :1000 AF:	PRECIF Inches	PAN EVAP : Inches	ELEVATION : Feet	AREA :1000 Ac	VOLUME :1000 AF	SALT :1000 Tons	SALT PPM
1960	1383	1.92	101.86	-233.75	224.20	5460.90	266858	35932
1961	1639	1.75	105.09	-232.35	226.89	5777.82	272654	34698
1962	1467	1.24	103.44	-231.73	228.61	5918.79	277841	34516
1963	1638	3.07	104.93	-230.35	232.50	6235.95	283633	33444
1964	1195	0.55	102.39	-231.06	230.50	6072.81	287859	34854
1965	1171	2.57	95.65	-231.36	229.92	6025.46	292000	35633
1966	1290	1.00	99.02	-231.26	229.92	6025.54	296561	36189
1967	1318	3.10	101.47	-231.11	230.36	6061.46	301221	36540
1968	1372	1.62	107.59	-231.20	230.09	6039.46	306072	37264
1969	1339	1.17	106.34	-231.40	229.53	5994.00	310807	38127
1970	1268	1.09	97.42	-231.39	229.57	5997.08	315291	38657
1971	1286	1.14	95.31	-231.17	230.18	6046.77	319838	38893
1972	1313	1.33	95.66	-230.86	231.07	6119.19	324481	38990
1973	1321	0.95	98.70	-230.74	231.41	6147.12	329152	39372
1974	1441	2.86	104.22	-230.26	232.75	6256.53	334247	39282
1975	1452	0.75	99.72	-229.70	234.36	6388.52	339381	39061
1976	1513	7.28	97.87	-228.28	238.48	6724.82	344731	37693
1977	1472	3.41	106.62	-227.95	239.43	6802.55	349936	37225
1978	1506	6.24	117.89	-227.52	239.52	6810.03	355261	38358
1979	1587	3.67	113.04	-227.49	240.79	6913.43	360873	38382
1980	1469	4.42	104.22	-227.01	242.19	7028.15	366067	38298
1981	1292	2.37	99.06	-227.18	241.71	6988.46	370636	38997
1982	1194	3.17	93.35	-227.34	241.22	6948.92	374858	39665
1983	1442	6.10	100.26	-226.46	243.85	7163.10	379957	39003
1984	1338	2.69	100.35	-226.52	243.67	7148.74	384688	39568
1985	1375	2.35	104.47	-226.69	243.17	7107.72	389550	40299
1986	1199	3.22	89.71	-226.65	243.29	7117.64	393790	40681

Prepared by Bookman-Edmonston Engineering, Inc. Values shown are calendar year amounts or end of year values.

ELEVATION AND SALINITY OF SALTON SEA
UNDER DIFFERENT INFLOW CONDITIONS

Condition	Estimated Elevation as of Dec. 1986 ^(a)	Elevation Difference from Historic	Estimated Salinity as of Dec. 1986 PPT	Salinity Difference from Historic PPT
1. Historic Inflow	-226.80(actual)	-	40.8	-
2. Historic Inflow Imperial I.D.	-226 ^(b)	-39	-	-
3. Historic Inflow without Coachella	-236.41	-9.61	55.9	+15.1
4. Historic Inflow without Mexico	-235.91	-9.11	55.5	+14.7
5. Historic Inflow Less 100,000 AF/yr. since 1950	-232.18	-5.38	48.1	+7.3
6. Historic Inflow Less 100,000 AF/yr. since 1975	-230.36	-3.56	45.9	+5.1
7. Historic Inflow Less 200,000 AF/yr. since 1975	-234.08	-7.28	52.5	+11.7
8. Historic Inflow Less Mexico over 100,000 AF/yr. since 1978	-230.12	-3.32	45.5	+4.7
9. Historic Inflow Plus 100,000 AF/yr. since 1975	-223.39	+3.41	36.9	-3.9
10. Historic Inflow Less Recent Storms	-229.25	-2.45	44.1	+3.3
11. Historic Inflow Less Recent Storms and Increase in Mexico over 100,000 AF/yr.	-223.18	-6.38	50.6	+9.8
12. Imperial Irrigation District	-248.16	-21.36	92.9	+52.1

(a) Computed Elevations adjusted to conform to actual Elevation.
(b) Estimated on basis of average inflow for last eleven years and net evaporation of 5.65 feet.

ANNUAL DECLINE IN SALTON SEA ELEVATION
 FOLLOWING ONE FOOT RISE

Year	Historical Elevation	Elevation Following One Foot Rise in 1961	Difference
1960	-233.75	-233.75	0
61	-233.35	-232.35	1.00
62	-232.65	-231.73	.92
63	-231.20	-230.35	.85
64	-231.85	-231.06	.79
1965	-232.00	-231.26	.74
66	-231.95	-231.26	.69
67	-231.75	-231.11	.64
68	-231.80	-231.20	.60
69	-231.95	-231.40	.55
1970	-231.90	-231.39	.51
71	-231.65	-231.17	.48
72	-231.30	-230.86	.44
73	-231.15	-230.74	.41
74	-230.65	-230.26	.39
1975	-230.05	-229.70	.35
76	-228.60	-228.28	.32
77	-228.25	-227.95	.30
78	-228.20	-227.92	.28
79	-227.75	-227.49	.26
1980	-227.25	-227.01	.24
81	-227.40	-227.18	.22
82	-227.55	-227.34	.21
83	-226.65	-226.46	.19
84	-226.70	-226.52	.18
1985	-226.85	-226.69	.16
1986	-226.80	-226.65	.15

HYDRO POWER GENERATION BY
IMPERIAL IRRIGATION DISTRICT

<u>Year</u>	<u>Total KWH Sales</u>	<u>Hydro KWH [1]</u>	<u>Water Diverted At Drop #1</u>	<u>KWH Per Ac. Ft.</u>
1960	585 529 375	207 474 600	2 983 860	69.5
1961**	597 122 118	210 340 550	2 957 200	71.1
1962	633 084 500	196 336 270	2 951 266	66.5
1963	587 500 600	214 153 708	2 991 429	71.6
1964***	575 088 500	196 599 260	2 770 474	71.0
1965	590 089 100	186 788 334	2 624 363	71.2
1966*	667 905 000	194 109 838	2 817 912	68.9
1967	700 733 100	193 542 751	2 719 861	71.2
1968	732 907 300	210 745 051	2 806 124	75.1
1969	819 466 400	198 855 524	2 675 833	74.3
1970	859 990 600	212 219 394	2 754 898	77.0
1971	889 058 600	224 198 000	2 883 960	77.7
1972	985 399 700	220 873 384	2 846 613	77.6
1973	1 056 094 300	226 787 174	2 956 013	76.7
1974[2]	1 069 867 100	232 883 436	3 072 327	75.8
1975	1 080 863 000	231 338 868	3 001 207	77.1
1976	1 118 758 900	214 857 356	2 783 630	77.2
1977	1 173 004 300	208 825 250	2 693 030	77.5
1978	1 225 132 700	206 942 410	2 671 798	77.5
1979	1 290 822 500	217 900 536	2 803 166	77.7
1980	1 264 906 800	214 619 042	2 769 495	77.5
1981	1 337 521 900	218 837 866	2 769 112	79.0
1982****	1 238 302 900	204 744 726	2 515 637	81.4
1983	1 248 090 600	203 370 380	2 416 885	84.1
1984*****	1 327 547 900	227 198 090	2 647 285	85.8
1985	1 393 085 800	235 897 760	2 616 876	90.1
1986	1 432 125 800	241 392 400	2 576 012	93.7

* - 11/66 Unit No. 2, Drop No. 3

** - 8/61 Unit # 1 & 2 Double Weir

*** - 10/64 Turnip

**** - 3/82 Unit Nos. 1 & 2, Drop No. 5

***** - 11/84 Drop No. 1 and 9/84 East Highline

[1]- Does not include Pilot Knob Generation.

[2]- Turnip off all year.

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HYDRO POWER GENERATION BY
IMPERIAL IRRIGATION DISTRICT (Cont'd.)

<u>Year</u>	<u>Power Revenue</u> \$	<u>% Sales From Hydro</u>	<u>Revenues From Hydro</u> \$	<u>Discharge Below Drop #1</u>	<u>Revenue Per Ac. Ft.</u>
1960	9 228 205	35.43%	3 269 553	2 983 860	\$1.096
1961	9 406 045	35.23	3 313 750	2 957 200	1.121
1962	10 038 166	31.01	3 112 835	2 951 266	1.055
1963	9 973 966	36.45	3 635 510	2 991 429	1.215
1964	10 018 618	34.19	3 425 365	2 770 474	1.236
1965	10 354 633	31.65	3 277 241	2 624 363	1.249
1966	11 486 318	29.06	3 337 924	2 817 912	1.185
1967	11 861 881	27.62	3 276 251	2 719 861	1.205
1968	12 150 519	28.75	3 493 274	2 806 124	1.245
1969	13 147 188	24.27	3 190 823	2 675 833	1.192
1970	13 652 153	24.68	3 369 351	2 754 898	1.223
1971	14 211 391	25.22	3 584 113	2 883 960	1.243
1972	15 445 996	22.41	3 461 448	2 846 613	1.216
1973	16 458 403	21.47	3 533 619	2 956 013	1.195
1974	21 734 658	21.77	4 731 635	3 072 327	1.540
1975	27 527 752	21.40	5 890 939	3 001 207	1.963
1976	30 328 694	19.20	5 823 109	2 783 630	2.092
1977	36 750 634	17.80	6 541 613	2 693 030	2.429
1978	40 732 693	16.89	6 879 752	2 671 798	2.575
1979	50 033 522	16.88	8 445 659	2 803 166	3.013
1980	55 974 360	16.97	9 498 679	2 769 495	3.430
1981	59 940 769	16.36	9 806 310	2 769 112	3.506
1982	70 753 950	16.53	11 695 628	2 515 637	4.649
1983	78 360 286	16.29	12 764 891	2 416 885	5.282
1984	80 614 594	17.11	13 793 157	2 647 285	5.210
1985	85 553 522	16.93	14 484 211	2 616 876	5.535
1986	87 855 562	16.86	14 812 448	2 576 012	5.750

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Irrigation Efficiency

Irrigation efficiency can be defined by different terms.

The terms commonly used, and as used in this report, are as follows:

Consumptive Use (CU): The quantity of water transpired by plants, retained in plant tissue, and evaporated from adjacent soil surfaces in a specific time period. Usually expressed in depth of water per unit area. As used here, CU is synonymous with evapotranspiration.

Conveyance System Efficiency: The ratio of the volume of water delivered to users to the volume of water introduced into the conveyance system. The conveyance system for the Imperial Irrigation District service area starts at Drop 1 on the All-American Canal.

On-farm Irrigation Efficiency: The ratio of the volume of water used for CU in cropped areas to the volume of water delivered to farm (applied water).

District Irrigation Efficiency: The ratio of the volume of water used for CU in cropped areas to the volume of water delivered to the irrigation district service area conveyance system (Drop 1).

Unit Irrigation Efficiency: The ratio of the volume of water used for CU in cropped areas, plus that amount necessary to maintain a favorable salt balance in the soil (leaching fraction), to the volume of water delivered for these purposes (applied water).

IMPERIAL IRRIGATION DISTRICT
AGRICULTURAL WATER USE EFFICIENCY

<u>Item</u>	<u>1977-79</u>	<u>1982</u>	<u>1986</u>
<u>Data</u>			
Irrigated Area, Ac. (1)	457,000	465,500	459,000
Diversion Below Drop No. 1, AF (2)	2,723,000	2,516,000	2,567,000
Agricultural Diversion Below Drop No. 1, AF (3)(a)	2,650,000	2,446,000	2,505,000
Agricultural Deliveries, AF (4)	2,285,000	2,138,000	2,193,000
Total Deliveries, AF (5)	2,348,000	2,199,000	2,255,000
Consumptive Use of Applied Irrigation Water, AF (6)	1,692,000	1,655,000	1,727,000
Leaching Requirement, AF (7)	280,000	280,000	280,000
<u>Agricultural Efficiency</u>			
Conveyance System Efficiency (4) (3)	86.2%	87.4%	87.5%
On-Farm Irrigation Efficiency (6) (4)	74.0%	77.4%	78.8%
District Irrigation Efficiency (6) (3)	63.8%	67.7%	68.9%
Unit Irrigation Efficiency ((6)+(7)) (4)	86.3%	90.5%	91.5%

(a) By ratio of total deliveries.

IMPERIAL IRRIGATION DISTRICT
UNIT AGRICULTURAL WATER USE AND EFFICIENCY

<u>Item</u>	<u>1977-79</u>	<u>1982</u>	<u>1986</u>
<u>Data</u>			
Irrigated Area, Ac.	457,048	465,500	459,000
Agriculture Diversion Below Drop No. 1, AF/Ac.	5.80	5.25	5.46
Agricultural Deliveries, AF/Ac.	5.00	4.59	4.78
Consumptive Use of Applied Irrigation Water, AF/Ac.	3.70	3.56	3.76
Leaching, AF/Ac.	.61	.60	.61
Tail Water AF/Ac.	.69	.43	.41
<u>Agricultural Efficiency</u>			
Conveyance System Efficiency	86.2%	87.4%	87.5%
On-Farm Irrigation Efficiency	74.0%	77.4%	78.8%
District Irrigation Efficiency	63.8%	67.7%	68.9%
Unit Irrigation Efficiency	86.3%	90.5%	91.5%

IMPERIAL IRRIGATION DISTRICT
WATER SUPPLY AND DELIVERIES, IRRIGATED AREA AND FLOW TO SALTON SEA

Year	Water Received By District at Drop 1			Water Delivered to Users			Area Irrigated			IID Inflow to Salton Sea		
	Amount 1000 AF (a)	5-Year Moving Average	Departure from Average in %	Amount 1000 AF (a)(b)	5-Year Moving Average	Departure from Average in %	Amount 1000 AF (c)	5-Year Moving Average	Departure from Average in %	Amount 1000 AF (d)	5-Year Moving Average	Departure from Average in %
1960	2,984		7.3	2,396		-2.4	434.5		-2.8	1,011		8.4
61	2,957		6.3	2,416		-1.5	435.5		-2.6	997		6.9
62	2,951		6.1	2,446		-0.3	429.5		-3.9	1,030		10.4
63	2,991		7.6	2,514		2.4	430.5		-3.7	1,090		16.8
64	2,770	2,931	-0.4	2,399	2,434	-2.2	431.5	432.3	-3.5	836	993	-10.4
1965	2,624	2,859	-5.6	2,312	2,417	-5.8	432.5	431.9	-3.2	809	952	-13.3
66	2,818	2,831	1.3	2,470	2,428	0.7	437.5	432.3	-2.1	931	939	-0.2
67	2,720	2,785	-2.2	2,365	2,412	-3.6	445.5	435.5	-0.3	954	924	2.3
68	2,806	2,748	0.9	2,476	2,404	0.9	441.0	437.6	-1.3	927	891	-0.6
69	2,676	2,729	-3.8	2,352	2,395	-4.2	441.5	439.6	-1.2	889	902	-4.7
1970	2,755	2,755	-0.9	2,418	2,416	-1.5	437.5	440.6	-2.1	947	930	1.5
71	2,884	2,768	3.7	2,535	2,429	3.3	442.0	441.5	-1.1	1,019	947	9.2
72	2,847	2,794	2.4	2,531	2,462	3.1	444.5	441.3	-0.6	990	954	6.1
73	2,956	2,824	6.3	2,670	2,501	8.8	444.5	442.0	-0.6	991	967	6.2
74	3,072	2,903	10.5	2,777	2,586	13.2	450.5	443.8	0.8	1,049	999	12.4
1975	3,001	2,952	7.9	2,704	2,643	10.2	456.5	447.6	2.1	1,054	1,021	13.0
76	2,784	2,932	0.1	2,515	2,639	2.5	458.5	450.9	2.6	1,011	1,019	8.4
77	2,693	2,901	-3.2	2,455	2,624	0	460.0	454.0	2.9	947	1,010	1.5
78	2,672	2,844	-3.9	2,441	2,578	-0.5	452.0	455.5	1.1	922	997	-1.2
79	2,803	2,791	0.8	2,571	2,537	4.8	460.0	457.4	2.9	983	983	5.4
1980	2,769	2,744	-0.4	2,520	2,500	2.7	460.5	458.2	3.0	969	966	3.9
81	2,769	2,741	-0.4	2,500	2,497	1.9	464.2	459.3	3.8	889	942	-4.7
82	2,516	2,706	-9.5	2,248	2,456	-8.4	465.3	460.4	4.1	815	916	-12.6
83	2,416	2,655	-13.1	2,180	2,404	-11.2	446.0	459.2	-0.2	793	890	-15.0
84	2,647	2,623	-4.8	2,386	2,367	-2.8	450.0	457.2	0.7	821	857	-12.0
1985	2,617	2,593	-5.9	2,335	2,330	-4.8	457.7	456.6	2.4	757	815	-18.9
1986	2,576	2,554	-7.4	2,337	2,297	-4.8	459.0	455.6	2.7	759	789	-18.6
Average	2,781			2,455			447.0			933		

(a) Data from IID Annual Reports and DWR 1981 Report.
(b) Deliveries from 1960-1963 increased by 10 percent to adjust for rerating of Delivery Gates.
(c) From IID Exhibit IID-H.
(d) Attachment 21

RELATIONSHIP OF INFLOW TO SALTON SEA FROM
IMPERIAL IRRIGATION DISTRICT TO DIVERTED
WATER, DELIVERED WATER AND IRRIGATED AREA

Annual Values 1960-1986

Year	: IID Inflow : to Salton Sea : as % of : Diverted Water	: IID Inflow : to Salton Sea : as % of : Delivered Water	: IID Inflow : to Salton Sea : as Ac. Ft. : Per Ac. of : Irrigated Area
1960	33.9	42.2	2.33
61	33.7	41.3	2.29
62	34.9	42.1	2.40
63	36.4	43.3	2.53
64	30.2	34.8	1.94
1965	30.8	35.0	1.87
66	33.0	37.7	2.13
67	35.1	40.3	2.14
68	33.0	37.4	2.10
69	33.2	37.8	2.01
1970	34.4	39.2	2.16
71	35.3	40.2	2.31
72	34.8	39.1	2.23
73	33.5	37.1	2.23
74	34.1	37.8	2.33
1975	35.1	39.0	2.31
76	36.3	40.2	2.21
77	35.2	38.6	2.06
78	34.5	37.8	2.04
79	35.1	38.2	2.14
1980	35.0	35.5	2.10
81	32.1	35.6	1.92
82	32.4	36.3	1.75
83	32.8	36.4	1.78
84	31.0	34.4	1.82
1985	28.9	32.4	1.65
1986	29.5	32.5	1.65

RELATIONSHIP OF INFLOW TO SALTON SEA FROM
IMPERIAL IRRIGATION DISTRICT TO DIVERTED
WATER, DELIVERED WATER AND IRRIGATED AREA

Five-Year Running Average 1960-1986			
Year	IID Inflow to Salton Sea as % of Diverted Water	IID Inflow to Salton Sea as % of Delivered Water	IID Inflow to Salton Sea as Ac. Ft. per Ac of Irrigated Area
1964	33.9	40.8	2.30
65	33.3	39.4	2.20
66	33.2	38.7	2.17
67	33.2	38.3	2.12
68	32.4	37.1	2.04
69	33.1	32.7	2.05
1970	33.8	38.5	2.11
71	34.2	39.0	2.14
72	34.1	38.7	2.16
73	34.2	38.7	2.19
74	34.4	38.6	2.25
1975	34.6	38.6	2.28
76	34.8	38.6	2.26
77	34.8	38.5	2.22
78	35.1	38.7	2.19
79	35.2	38.7	2.15
1980	35.2	38.6	2.11
81	34.4	37.7	2.05
82	33.9	37.3	1.99
83	33.5	37.0	1.94
84	32.7	36.2	1.87
1985	31.4	35.0	1.78
1986	30.9	34.3	1.73

RELATIONSHIP OF INFLOW TO SALTON SEA FROM
IMPERIAL IRRIGATION DISTRICT TO DIVERTED
WATER, DELIVERED WATER AND IRRIGATED AREA

Five-Year Running Average 1960-1986						
Year (Last Year of 5 Years)	Water Received at Drop 1 1,000 AF	IID Inflow to Salton Sea 1,000 AF	Irrigated Area 1,000 AF	Amount of Water Received at Drop 1 Per Irrigated Acre	IDD Inflow to Salton Sea Per Irrigated Acre	
1964	2,931	993	432.3	6.8	2.3	
1965	2,859	952	431.9	6.6	2.2	
1966	2,831	939	432.3	6.5	2.2	
1967	2,785	924	435.5	6.4	2.1	
1968	2,748	891	437.6	6.3	2.0	
1969	2,729	902	439.6	6.2	2.0	
1970	2,755	930	440.6	6.3	2.1	
1971	2,768	947	441.5	6.3	2.1	
1972	2,794	954	441.3	6.3	2.2	
1973	2,824	967	442.0	6.4	2.2	
1974	2,903	999	443.8	6.5	2.3	
1975	2,952	1,021	447.6	6.6	2.3	
1976	2,932	1,019	450.9	6.5	2.3	
1977	2,901	1,010	454.0	6.4	2.2	
1978	2,844	997	455.5	6.2	2.2	
1979	2,791	983	457.4	6.1	2.2	
1980	2,744	966	458.2	6.0	2.1	
1981	2,741	942	459.3	6.0	2.0	
1982	2,706	916	460.4	5.9	2.0	
1983	2,655	890	459.2	5.8	1.9	
1984	2,623	857	457.2	5.7	1.9	
1985	2,593	815	456.6	5.7	1.8	
1986	2,554	789	455.6	5.6	1.7	

REASONABLE WATER USE

Reasonableness of water use depends upon the circumstances of each case. There is no fixed definition or formula.

1. Circumstances relate to the relationship of a particular use to other potential beneficial uses considering hydrologic, economic, social, environmental, and energy factors.
2. These circumstances may vary with time, place, available water supply, existing and estimated future demands, water costs, societal views, environmental relations and energy consequences.

REASONABLE USE OF WATER
By
IMPERIAL IRRIGATION DISTRICT

Reasonable use by Imperial Irrigation District of its vested water rights means the distribution, use and disposal of its water supply in a manner which:

1. Provides a dependable supply of water for the municipal, industrial, domestic and agricultural demands in the amounts required when and where needed;
2. Conforms with accepted standards of water distribution and use practices for the periods of time under consideration; and
3. Demonstrates good management practices to meet future needs while considering financial and system constraints.

CONSIDERATIONS IN ASSESSING
REASONABLENESS OF WATER USE

1. Beneficial uses of water saved.
2. Whether excess water serves beneficial and reasonable purposes.
3. Benefits and detriments of water saved.
4. Characteristics of water supply.
5. Amounts of water reasonably required.
6. Amounts of water used.
7. Amounts and reasonableness of the cost of saving water.
8. Conformity of water use practices with local customs.
9. Existence of physical plan or solution to make beneficial use of conserved water.

IMPERIAL IRRIGATION DISTRICT
ACTIONS TO IMPROVE WATER DELIVERY,
USE AND DISPOSAL EFFICIENCY

Structural

Canal Lining Program
Regulatory Reservoirs Constructed
Desilting Basins
Seepage and Ground Water Recovery Facilities
Improved Farm Delivery Gates
Install and Maintain Waste Boxes of Standard Design
Automatic Gate Monitoring and Control Devices

Non-Structural

Allocate Funds for Water Conservation
13 Point Program
21 Point Program
Water Conservation Advisory Board
Participate in Design of Tile Drains
Tailwater Control Checking and Triple Charges
Fines for Tampering with Gates
Flow Data Measuring and Hydrologic Record Keeping
Install Recorders on Spills - Data Collection and Evaluation
Cooperation with USBR (1964, Title 43)
Participate with USBR in Water Conservation Study
Flexible Scheduling of Deliveries
Encourage Use of Drain Water
Drainage Water Delivery to Fish and Game
Provide Radio Equipment
IMS Program
Participation in and Contribution to Water Use Research
IID Staffing Ratios
Education and Public Relations

CONDITIONS THAT RESTRICT IRRIGATION EFFICIENCY

Conveyance System

Distance from Diversion to Farms - over 100 miles

Weather Changes after Diverted

Sudden: Rain Reduces Need

: Hot Winds Increase Need

Large and Long All American Canal through Sand Dunes

Seepage Losses

Evaporation Losses

Aquatic Weeds Affect Flow

Wind

Distribution Systems

In Place Since Early 1900's

Modernization Disrupts Agriculture

Large East Main and West Main Along Pervious

Area - High Seepage

Aquatic Weed Control

Wind Action

Algae and Moss Control

Water and Soil

Water Quality

Computed Leaching Requirement (Steady State Concept)

Soil and Crop Conditions Increase Leaching Requirement

Soils

- Hetrogeneous, Vertically and Horizontally

- Intake Rate Slower on Salty Areas

- Moisture Holding Capacity Lower on Sandy Areas

- Leaching During Times When Minimum Nitrogen Pickup

- Over-leach for Salt Sensitive Crops

Farm Systems

- In Place Since Early 1900's

- Tile Lines Restrict Regrading (Level Basins)

- Lined Farm Head Ditches Fix Upper End

- Tailwater Boxes Fix Lower End

FACTORS TO BE ADDRESSED IN
ASSESSING REASONABLENESS OF WATER USE

1. Area
 - Location
 - Size
 - Topography
 - Drainage
2. Climate
 - Temperature
 - Wind
 - Humidity
 - Daylight Hours
 - Rainfall
 - Crop Growing Season
3. Soils
 - Type
 - Uniformity
 - Texture
 - Depth
 - Infiltration Rates
 - Depth to Ground Water
4. Land Use
 - Population
 - Industry
 - Agriculture
 - Crop pattern
 - Irrigation methods
 - Farming practices
5. Water Supply
 - Sources
 - Local
 - Surface
 - Ground Water
 - Imported
 - Availability
 - Quality
 - Dependability
 - Water Contracts
 - Water Rights
 - Water Cost

FACTORS TO BE ADDRESSED IN
ASSESSING REASONABLENESS OF WATER USE (Cont'd.)

6. Water Requirements and Use
 - Municipal and Industrial
 - Domestic
 - Agriculture
 - Consumptive Use
 - Precipitation
 - Applied Water
 - Leaching
 - Tailwater
 - Operational
 - Conveyance Losses
7. Water Supply and Drainage Organization
 - Authority and Responsibility
 - Objectives
 - Operation Policy
 - Organization
 - Water Conservation
 - Water Quality Control Plans
 - Taxes and Water Rates
 - Public Relations
 - Education
 - Research
 - History
8. Water Distribution Facilities
 - History
 - Water Diversion and Conveyance Facilities
 - Water Distribution Facilities
 - Operational Requirements
 - Operational Characteristics
 - Operational Losses
 - Conveyance Losses
9. Water Distribution Policies
 - Operational Policies
 - Water Conservation
 - Water Supply Allocation
 - Water Orders
 - Water Deliveries
10. Farm Irrigation
 - Irrigation Methods
 - Farming Practices
 - Irrigation Characteristics
 - Drainage
 - Leaching
 - Tile Drains

FACTORS TO BE ADDRESSED IN
ASSESSING REASONABLENESS OF WATER USE (Cont'd.)

11. Drainage

- Policies
- Municipal and Industrial Wastes
- Leaching
- Tile Drains
- Waste Boxes
- Tailwater
- Drainage Facilities
- Ground Water
- Storm Runoff
- Quality
- Disposal
- Use of Disposed Water
- Effect of Disposal

12. Water Use Efficiencies

- On Farm
- Conveyance
- District
- Unit Irrigation
- Comparison

13. Water Conservation

- Practices
- Opportunities
- Water Savings
- Use of Water Saved
- Plans for Using Saved Water
- Benefits
- Cost

QUESTIONS REGARDING REASONABLENESS
OF USE OF WATER BY
IMPERIAL IRRIGATION DISTRICT

1. Since 1960, have the methods of use and uses of water by the IID and its water users occurred in a manner which comports with usual and acceptable practices for irrigation systems when compared to the methods of use by other irrigation systems and their water users?
2. Since 1960, have the methods of use and uses of water by IID and its water users occurred in a manner which would have been normally and ordinarily foreseeable?
3. Since 1960, have the methods of use and the use of water by IID and its water users occurred in a careful manner?
4. Since 1960, have the IID water supply, distribution and drainage systems been operating and using water in a reasonable manner?
5. Since 1960, have the methods used by the IID in diverting and distributing water to its water users been reasonable?
6. Since 1960, have the methods used by the IID in diverting and distributing water to its water users resulted in a unreasonable method of use or a waste of water?

USE OF "EXCESS" WATER FOR
GROUND WATER RECHARGE

It has been stated that Colorado River Water could be used for ground water recharge or make State Project Water available for ground water recharge in Coachella Valley, San Fernando or Chino Basin. Imperial I.D. actions have had no effect on ground water recharge in these basins.

The following should be noted:

1. MWD has had "excess" water in substantial quantities available for every year beginning in 1973 except for 1977. The excess capacity is shown on page 3 of this Attachment and has averaged about 700,000 acre-feet per year since 1975.

2. MWD has sold water for ground water replenishment every year since 1958. About 118,000 acre-feet of water has been spread in Chino Basin as shown on page 4.

3. MWD has since 1958 provided water at a reduced price for ground water spreading.

4. An intensive study of the Chino Basin Groundwater Storage Program was made in the early 1980's. The plan recommended spreading of 25,000 acre-feet per year, injection of 30,400 acre-feet per year and in-lieu replacement at 25,900 acre-feet per year or a total of 81,300 acre-feet per year. Metropolitan in late 1986 initiated the environmental process to begin a major storage program.

5. Current water quality goals in the Chino Basin allow replenishment with State Project Water and not Colorado River Water for quality reasons.

6. Metropolitan in 1984 began spreading large quantities of Colorado River Water in Coachella Valley as advance delivery in an exchange program.

7. Storage of water in San Fernando Basin is currently limited because of concerns for volatile organics.

The facts are: (1) That MWD has had adequate supplies and encouraged ground water spreading by a reduced price; (2) Local entities or others did not choose to spread additional water; and (3) A reduction in use by Imperial ID would not have resulted in any increase in spreading in Chino Basin, Coachella Valley or San Fernando Basin. This may be a factor only some time in the future.

METROPOLITAN WATER DISTRICT IMPORTS,
IMPORT CAPACITY
AND UNUSED CAPACITY

(Values in 1000 acre-feet)

Calendar Year	Imports			Metropolitan Capacity			Unused Capacity(e)		
	Colorado: River(a)	State: Project(b)	Total	Colorado: River(c)	State: Project(d)	Total	Colorado: River	State: Project	Total
1970	1,195	0	1,195	1,212	-	1,212	17	-	17
71	1,207	0	1,207	1,212	-	1,212	5	-	5
72	1,220	72	1,292	1,212	72	1,284	0	0	0
73	1,165	160	1,325	1,212	475	1,687	47	315	362
74	1,125	278	1,403	1,212	475	1,687	87	197	284
1975	782	526	1,308	1,212	1,031	2,243	430	505	935
76	800	618	1,418	1,212	1,031	2,243	412	413	825
77	1,285	190	1,475	1,212	1,031	2,243	0	0	0
78	715	508	1,223	1,212	1,031	2,243	497	523	1,020
79	809	477	1,286	1,212	1,031	2,243	403	554	957
1980	817	532	1,349	1,212	1,031	2,243	395	499	894
81	825	796	1,621	1,212	1,031	2,243	387	235	622
82	711	691	1,402	1,212	1,031	2,243	501	340	841
83	903	344	1,247	1,212	1,031	2,243	309	687	996
84	1,231	457	1,688	1,212	1,031	2,243	0	574	574
1985	1,269	698	1,967	1,212	1,031	2,243	0	333	333
1986	1,298	756	2,054	1,212	1,031	2,243	0	275	275

- (a) Data from State Colorado River Board. Includes water spread in Coachella Valley.
 (b) Data from DWR Bulletin 132 series.
 (c) Annual entitlement. Actual capacity with nine pump flow is greater.
 (d) Existing capacity as limited by facilities on East Branch and Sepulveda Feeder system.
 (e) State had surplus water available in all years except 1977. Full Colorado River entitlement of 1,212,000 ac. ft. was available to Metropolitan for period shown.

HISTORICAL SPREADING OF
IMPORTED WATER IN CHINO BASIN

<u>Fiscal Year</u>	<u>Water Purchased For Spreading in Chino Basin in Ac.Ft</u>
1964-65	3,002
66	0
67	526
68	2,229
--	
1973-74	840
1974-75	2,001
76	939
77	531
78	6,976
79	12,521
1979-80	14,698
81	15,565
82	19,042
83	13,188
84	13,777
1984-85	<u>12,188</u>
Total	118,023

FATE OF UNUSED WATER BY
IMPERIAL IRRIGATION DISTRICT

Had Imperial Irrigation District used less water, the unused water would have temporarily increased the water in storage on the Colorado River because there were no customers for the water.

The increased amount of water in storage would have slightly increased the reservoir evaporation. All remaining unused water would have been released for flood control in 1979-80 or 1983. Page 2 shows the annual amount of water flowing to Mexico. Note the excess deliveries in 1979-80 and from 1983 to date.

DELIVERIES OF COLORADO RIVER
WATER TO MEXICO

(Values in Acre-Feet)

Calendar Year	Total Arrivals	Basic Treaty Delivery	Excess Arrivals(a)
1977	1,779,000	1,500,000	279,000
78	1,727,000	"	227,000
79	3,345,000	"	1,845,000(b)
80	7,195,000	"	5,695,000(b)
81	2,191,000	"	691,000
82	1,699,000	"	199,000
83	14,369,000	"	12,869,000(c)
84	15,669,000	"	14,169,000(c)
85	11,942,000	"	10,442,000(c)
86	10,924,000	"	9,424,000(c)

Source: Colorado River Board

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- (a) Amount in range of 200,000 ac. ft. represents primarily adjustments for quality reasons.
 - (b) Primarily anticipated flood releases in 1979 and 1980.
 - (c) Large flood releases beginning in 1983.

EFFECTS OF STORMS ON ELEVATION OF SALTON SEA

Since February of 1976 there have been 13 months in Salton Sea area with rainfall of over 1 inch. Analyses indicate that as of January 1987 the residual effects of these storms on the Salton Sea were an increase in level of 2.45 feet over that expected without the storms; the results are shown on pages 3 and 4.

This study was made by comparing the actual change in Salton Sea elevation for months with rainfall over 1 inch, with the normal change in sea level expected for that month. The normal monthly change in Salton Sea was determined from analyzing several years of record and discarding those months with unusual changes.

As an example, in February the Salton Sea will normally rise by 0.25 feet. In February, 1976, when rainfall was 2.02 inches, the Sea actually rose 0.45 feet; thus 0.20 feet is considered to be the result of the February storms. Between 1976 and 1987 it is estimated that 48% of this inflow would have evaporated due to increased surface area; thus the residual effect of this storm was 0.10 feet in January 1987. Thirteen storms of over 1 inch of rain since 1976 caused the Salton Sea to rise 3.95 feet.

As shown on page 3, rainfall from the 13 storms totaled 26.71 inches (2.23 feet) which caused a rise in the Sea of 3.95 feet including associated surface inflow. Allowing for evaporation, the residual effect of this increase was 2.45 feet as of January 1987.

On page 4 is an annual accumulation of the effects of the storms showing the residual effect at the end of each year. The maximum residual effect occurs at the end of 1983 when the total effect is 2.82 feet. The computed elevation shows that the Sea elevation without the storms is nearly stabilized at about 229.5 feet below sea level.

EFFECTS OF STORMS ON ELEVATION OF SALTON SEA

(Values in Feet Unless Otherwise Noted)

Month (1)	Rainfall Inches (2)	Actual Changes In Salton Sea Elevation (3)	Normal Changes In Sea Elevation For Month (4)	Effect of Weather On Change In Sea Elevation (5)	Years From Storm To 1987 (6)	Evaporation Factor (7)	Residual Effect of Storms In 1987 (8)
Feb.	2.02	+ .45	+ .25	+ .20	10	.48	+ .10
Sept.	4.02	+ .80	-.21	+1.01	10	.48	+ .48
Aug.	2.51	+ .50	-.31	+ .81	9	.52	+ .42
Jan.	2.05	+ .25	+ .26	None	8	.55	-
Oct.	1.04	0.00	-.16	+ .16	8	.55	+ .09
Jan.	1.63	+ .25	+ .26	None	7	.60	-
Jan.	1.02	+ .40	+ .26	+ .14	6	.64	+ .09
Feb.	2.93	+ .55	+ .25	+ .30	6	.64	+ .20
Dec.	1.47	+ .30	+ .12	+ .18	4	.74	+ .13
Mar.	3.23	+ .55	+ .19	+ .36	3	.80	+ .29
Aug.	2.54	+ .30	-.31	+ .61	3	.80	+ .49
Dec.	1.23	+ .30	+ .12	+ .18	2	.86	+ .16
Jul.	1.02	-.15	-.10	None	0	1.00	-
TOTAL	26.71	4.50	3.95	3.95			2.45

(1) All months since Jan. 1976 which have rainfall totals in excess of 1.0 inches.

(2) Averaged monthly rainfall at Salt Farm, Sandy Beach and Devils Hole.

(3) Change in Salton Sea level based on IID station near Fig Tree John Spring.

(4) Average change in Salton Sea elevation for month determined as average change for month for all years from 1976 through 1984 excluding months with rainfall of 0.5 inches or greater.

(5) Column (3) less Column (4). This shows the true effect that the storm has on the elevation. As an example in Feb. 1976 the Sea rose 0.45 feet with rainfall of 2.02 inches. Since in Feb. the Sea normally rises 0.25 feet, 0.20 feet of rise is attributable to the storm.

(6) Number of years (assumed whole numbers) from storm until 1987.

(7) Factor accounting for evaporation of additional storm water. As an example, of the water added in 1976, only 48 percent remains. Factor is based on average net evaporation of 5.66 feet per year on increased area.

(8) Column (5) times Column (7) is the amount left from storms as of Jan. 1987.

ANNUAL EFFECT OF STORMS
ON ELEVATION OF SALTON SEA

Season	: Annual : Elevation : Increase : Caused : by : Storms (a)	: : : : Increased : Evaporation : (in feet)	: : : : Accumulated : Change in : Elvevations	: : : : : : : Comparison with : Actual Elevations : At End of Year : Without : Historic : Storms
1975				230.05 230.05
1976	1.21	0	1.21	228.60 229.81
1977	.81	.09	1.93	228.25 230.18
1978	.16	.16	1.93	228.20 230.13
1979	0	.16	1.77	227.75 229.52
1980	.44	.13	2.08	227.25 229.33
1981	0	.14	1.94	227.40 229.34
1982	.18	.12	2.00	227.55 229.55
1983	.97	.15	2.82	226.65 229.47
1984	.18	.20	2.80	226.70 229.50
1985	0	.19	2.61	226.85 229.46
1986	0	.16	2.45	226.80 229.25

COLORADO WATER USE BY CALIFORNIA AGENCIES (a)

(Values in Thousands of Acre-Feet)

Calendar Year	All American Canal										Total
	Imperial : Irrigation : District	Coachella : Valley : Water : District	Subtotal	Palo Verde : Irrigation : District	Yuma : Project : Reservation : Division	Metropolitan : Water : District					
1961	3,036	522	3,558	380	40	1,054	5,032				
62	3,006	565	3,571	381	46	1,029	5,027				
63	3,062	538	3,600	367	45	1,065	5,077				
64	2,808	511	3,319	401	50	1,092	4,862				
1965	2,688	515	3,203	349	44	1,180	4,776				
1966	2,886	480	3,366	407	53	1,121	4,947				
67	2,770	456	3,226	364	48	1,182	4,820				
68	2,864	473	3,337	393	58	1,105	4,893				
69	2,714	486	3,200	391	60	1,139	4,790				
1970	2,808	444	3,252	409	51	1,195	4,907				
1971	2,939	466	3,405	465	49	1,207	5,126				
72	2,903	501	3,404	436	47	1,220	5,107				
73	3,009	512	3,521	475	48	1,165	5,209				
74	3,133	552	3,685	457	44	1,125	5,311				
1975	3,047	566	3,613	451	46	782	4,892				
1976	2,831	516	3,347	387	47	800	4,581				
77	2,717	499	3,216	431	41	1,285	4,973				
78	2,715	501	3,216	425	45	715	4,401				
79	2,844	523	3,367	462	49	809	4,687				
1980	2,817	526	3,343	409	40	817	4,609				
1981	2,839	447	3,286	518	41	825	4,670				
82	2,565	420	2,985	456	58	711	4,210				
83	2,509	355	2,864	322	36	903	4,125				
1984	2,687	359	3,046	332	36	1,231	4,645				
1985	2,678	336	3,014	387	41	1,269	4,771				
1986	2,693	342	3,035	404	33	1,298	4,770				

(a) Diversions less return to the River. Data from Colorado River Board.

SALTON SEA ELEVATION - FEBRUARY 1984

State Water Resources Control Board in Decision 1600 (page 57-58) reports that the elevation of Salton Sea in February 1984 was the highest level recorded in February in 70 years. The Decision further indicates that the storms in recent months did not cause the rise because rainfall in the Colorado Desert for period October 1, 1983 through April 30, 1984 was 70 percent of average. The Board concludes that IID water conservation efforts are not sufficient to control the rising elevation of the Salton Sea. The following relates to the Board's Decision.

1. Because of the variation in Salton Sea level during the year it is necessary to compare elevations for the same time each year. Thus a proper comparison for February 1984 levels is with February 1983.

2. Elevation of Salton Sea (USGS) were as follows:

February 29, 1984	-227.1 feet
February 28, 1983	-227.7 feet
rise	<u>0.6 feet</u>

3. Storms occurred in March 1983 and August 1983 which totaled 5.77 inches at the three Salton Sea stations. Salton Sea rainfall for 1983 totaled 8.10 inches, 3.4 times average. Rainfall at Imperial for 1983 totaled 5.72 inches or 195 percent of the 72-year average of 2.93 inches.

4. The rise in Salton Sea attributable to the March 1983 and August 1983 storms, (based on Attachment 39) was 0.97 feet.

5. Inflow from Mexico was 244,430 acre-feet from March 1983 through February 1984 (USGS), which is a substantial increase over the 110,000 acre-feet per year average which occurred during the 1970's. This increase is equivalent to about 0.58 feet of rise in Salton Sea.

6. The rise in the Salton Sea from storms and increased flow from Mexico is estimated to be equivalent to 1.55 feet from March 1983 through February 1984. The measured rise during the period was 0.6 feet. Had the storms not occurred and had Mexico not increased its inflow the computed decline in sea level is 0.95 feet.

7. The change in Salton Sea level for the last four years (using IID station) are as follows:

<u>Year</u>	<u>Elevation at End of Year</u>	<u>Rise in Feet</u>
1982	-227.55	
1983	-226.65	0.90
1984	-226.70	-0.05
1985	-226.85	-0.15
1986	-226.80	-0.05

8. Conclusion stated on page 57-58 in Decision 1600 regarding change in Salton Sea elevation based only on February 1984 elevations is incorrect. The reference to rainfall from October 1983 through April 1984 missed the storms causing the elevation change. Further, it gave no consideration to actions by Mexico.